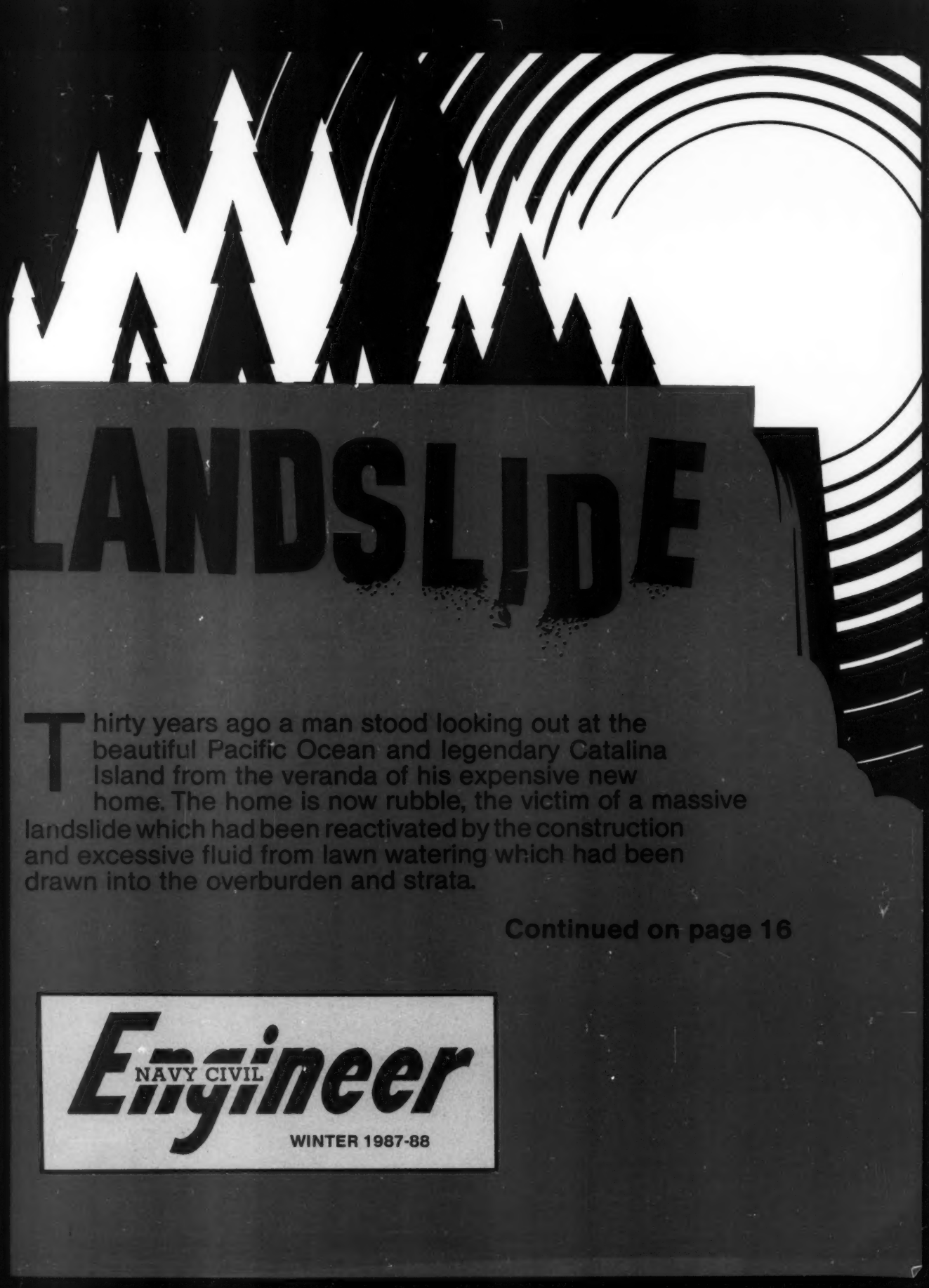

LANDSLIDE

Thirty years ago a man stood looking out at the beautiful Pacific Ocean and legendary Catalina Island from the veranda of his expensive new home. The home is now rubble, the victim of a massive landslide which had been reactivated by the construction and excessive fluid from lawn watering which had been drawn into the overburden and strata.

Continued on page 16

NAVY CIVIL Engineer
WINTER 1987-88

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The cover on this issue was the brainstorm of new contributing artist, Joan Hines, highlighting two-time Commander's Award-winning author John Buffalo's article on landslides.

NAVY CIVIL Engineer

WINTER 1987-8 Vo. XXVII, No. 3

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Replaced PCB equipment could have prevented a

CONTAMINATED SHIPYARD

By LEIGHTON WONG
P.E., Hawaii
Environmental Engineer
Pacific Division
Naval Facilities Engineering Command
Pearl Harbor, Hawaii

and

STANLEY KONNO
P.E., Hawaii
Environmental Engineer
Navy Public Works Center
Pearl Harbor, Hawaii

What innocuous piece of equipment can malfunction and cost the Navy over $2.1 million and 16,000 man-hours, and disrupt one of the largest shipyards in the country? A 300-KVA transformer! It happened to the Naval Shipyard at Pearl Harbor and it could occur at your activity, in your city or town, and even in your neighborhood.

PCB, short for polychlorinated biphenyl, is a light yellow, oily liquid or solid white powder with a weak odor, used as an insulator in some electrical equipment. Although PCBs have not been found to cause cancer in humans, it is a persistent chemical in the environment (it does not readily break down), and is therefore strictly regulated by the U.S. Environmental Protection Agency (EPA) because of its long-term potential for contamination, and accumulation in the food chain and body tissues.

EPA allows PCB equipment to remain in service provided that inspection and record-keeping requirements are complied with. Once excess to an activity's needs, equipment containing PCBs in concentrations greater than 50 parts per million (ppm) must be disposed of in specially designed landfills or destroyed by EPA-approved incinerators.

At 1:15 p.m. on July 15, 1986, a transformer containing a maximum of 269 gallons of dielectric fluid at 270,900 ppm PCBs overpressurized from internal heat and blew the inspection cover off the top of the casing. This particular transformer sat outdoors in a concrete enclosure open to the sky next to the shipyard cafeteria.

The explosion released a cloud of vaporized transformer oil into the atmosphere. The fallout from this cloud contaminated motor vehicles, buildings, submarines, dry docks, and parking lots over an area of approximately 28 acres, downwind. Only 10 gallons of PCB insulating fluid were released.

The cleanup and lost time has cost the Navy over $2,100,000 to date. Public Works Center (PWC), Pearl Harbor, responsible for the cleanup in the immediate vicinity of the transformer, had

personnel work around the clock on 14-hour shifts, seven days a week, over a period of a month before the area could be partially returned to normal use. Decontamination activities are still proceeding on some of the buildings. Costs are approaching $1 million for PWC Pearl Harbor's part in the cleanup.

The Pearl Harbor Naval Shipyard was responsible for cleanup of the contaminated areas in the controlled industrial area (CIA). Both shifts at two of the three drydocks at Pearl Harbor on the night following the incident were cancelled, disrupting ship repair work. The cost for lost time and cleanup amounted to approximately $1.2 million.

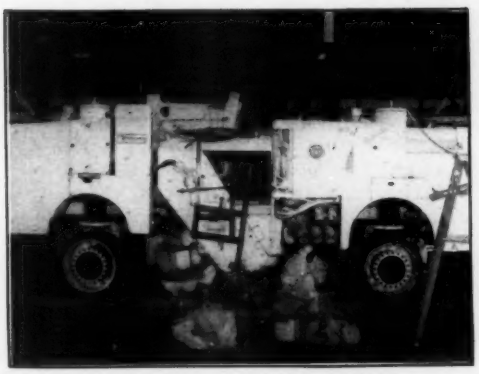
Immediately following the incident, the areas downwind and in the vicinity of the transformer were sealed off by naval base security. All vehicles in a downwind parking lot were impounded and the owners driven home by Navy personnel in government vehicles. Response personnel from PWC Pearl Harbor used kerosene-soaked rags in their initial attempts to decontaminate the vehicles that night.

Laboratory analyses of samples taken after wipedown showed that decontamination using kerosene was not successful. Response personnel then tested ethyl alcohol, isopropyl alcohol, and enamel paint thinner in place of the kerosene and the results indicated that ethyl alcohol and isopropyl alcohol worked best.

Rags soaked in either ethyl alcohol or isopropyl alcohol were used to complete decontamination of the remaining vehicles. Toothbrushes were also used to clean cracks and crevices to ensure complete decontamination of the vehicles.

The exterior of the transformer was decontaminated with kerosene-soaked rags. Workers drained the transformer oil with hoses and a small portable pump into five 55-gallon drums. A crane removed the transformer which was sent to the PWC Pearl Harbor PCB storage area along with the five drums of PCB liquid within 10 hours of the incident.

Contaminated asphalt was removed from the pavement near the transformer explosion. Asphalt visibly contaminated with PCBs was placed into



Heavy equipment is decontaminated.

Kerosene is drained into pails for use during the clean-up operations.

55-gallon drums for disposal at an EPA-approved site on the mainland. The area has since been repaved.

The food preparation area of the shipyard cafeteria was contaminated and the cafeteria was closed. Alcohol-soaked rags were used to decontaminate the area. Decontamination continued until no traces of PCBs were found in laboratory analyses. Since this was a food handling and preparation area, extra care was taken to ensure complete decontamination. An elaborate sampling matrix was developed that provided for complete and comprehensive analysis. Additionally, all food-handling equipment was individually sampled. All rubber and plastic items that tested positive were discarded into drums that will be shipped to the continental United States (CONUS) for proper disposal or incineration.

As an example of the efforts undertaken to ensure complete decontamination, workers also disassembled toasters and cleaned their heating coils. The cafeteria took more than to decontaminate and was cleared to reopen on August 18, 1986. While being decontaminated, portable cooking equipment was used and meals served at temporary facilities.

The shipyard evacuated all personnel from affected areas except for ships' crews. That evening, approximately 50 employees provided security and conducted sampling of the area to determine the exact extent of contamination. Samples were collected from buildings, submarines, equipment, and drydocks. Beginning the next morning, 400 workers were mobilized to begin cleanup of contaminated areas downwind from the failed transformer with kerosene-soaked rags.

Initial efforts by the shipyard were concentrated on decontaminating the drydocks and the sub-

A worker places contaminated materials into the drums.

marines in them. After Drydock 1 was decontaminated and released for use, workers then concentrated on Drydock 2. Upon completion of the drydocks, efforts were made to decontaminate the cranes and buildings.

Portable equipment which required a large amount of manpower to decontaminate and was not immediately needed were removed from the cleaned areas and cleaned after large scale decontamination efforts were completed. Shipyard decontamination efforts took approximately two weeks, and consisted primarily of wiping the surfaces of contaminated items with kerosene-soaked rags.

One issue that hampered clean-up activities was the determination of "how clean is clean."

Approximately 1,300 people reported to the naval medical clinic for evaluation. Twenty-five people either had evidence of PCBs on their clothing or arms, or were found to have some symptoms of exposure. All personnel were treated and released, and no long-term health problems are anticipated.

Approximately 7,000 square feet of walls and roofs of buildings located downwind of the release required decontamination. Some of the buildings were re-roofed. Walls were wiped with kerosene-soaked rags. Of course, laboratory analyses were conducted on samples taken from the buildings after decontamination to ensure that concentrations of PCBs were below acceptable levels.

An issue that hampered clean-up activities was the determination of "how clean is clean." It was quickly learned that there are no federal or local standards or regulations for PCB spill cleanup. It was also learned that clean-up policies differed between regions of the EPA, although a draft national policy for PCB clean-up is being developed by EPA headquarters in Washington, D.C. After many telephone calls with EPA Region IX, the EPA region under which Hawaii falls, it was agreed that the following limits would be used for the clean-up at Pearl Harbor:

Vehicles	
Exposed Paint and Chrome Surfaces	0.5 ug/100 cm^2
Restricted Cracks, and Rubber and Sealer Areas	5 ug/100 cm^2
Exterior Walls and Roofs	
Surfaces Below Six Feet	10 ug/100 cm^2
Other Portions	100 ug/100 cm^2
Asphalt, Concrete, and Soil	Background*

*Higher limits may be acceptable to EPA on a case-by-case basis.

ug = *micrograms*

The above limits were also reviewed and concurred with by the Naval Medical Clinic, Pearl Harbor. Clean-up procedures were adopted by PWC Pearl Harbor crews to meet these limits and extensive laboratory testing, retesting, and check testing were conducted to ensure that these limits were met.

An EPA representative, familiar with PCB-clean-up operations, visited the site three days after the incident and was satisfied with the Navy's clean-up actions. The Pacific Division, Naval Facilities Engineering Command at Pearl Harbor has repeatedly discussed clean-up procedures with EPA Region IX officials throughout the clean-up operation.

Two thousand drums of PCB-contaminated materials have already been generated by this clean-up action. Contaminated materials include insulating fluids from the transformer, asphalt, roofing materials, protective clothing, and rags. A total of 3,000 drums are expected to be generated upon completion of clean-up action.

Because there are no approved incinerators nor disposal sites in Hawaii, all of the drums must be shipped over 2,500 miles to CONUS. The estimated cost of properly incinerating or disposing of the drums is $500 per drum, equating to a total

cost of $1.5 million. The Defense Reutilization and Marketing Office, Hawaii, will pay for the cost of disposal which is not included in the funds the Navy has expended to date.

Personnel working in areas of PCB contamination were issued air-purifying respirators with organic vapor cartridges, and disposable gloves, boots, and coveralls. Approximately 5,000 sets of these disposable garments will be used by the completion of clean-up action, and require disposal after use. Used garments are a part of the contents of approximately 3,000 drums which will have to be shipped to CONUS for destruction in an approved incinerator or disposal in an acceptable landfill.

Over 5,500 samples were analyzed for PCBs; 1,000 samples alone were required to ensure that the food preparation area of the cafeteria was completely decontaminated. Other samples were analyzed from soil, asphalt, buildings, submarines, and cars to determine the extent of contamination and to ensure that decontamination had been properly accomplished. The analyses for PCBs were conducted by the shipyard, PWC Pearl Harbor, and two private laboratories.

Legal issues remain concerning the decontamination of the private vehicles. Some of the owners feel that decontamination was inadequate and initially refused their vehicles. Although they later accepted their vehicles, they continue to seek compensation from the Navy based on their opinion that the PCB clean-up levels should be lower than that recommended by EPA and that difficult-to-decontaminate sections of their vehicles such as air-conditioning ducts must be cleaned although there are no reasons to believe that these sections are contaminated. These problems have to be addressed and will probably take years to resolve.

Problems still remain for the clean-up crews. The higher sections of the exterior walls of some of the buildings have not been decontaminated. PWC Pearl Harbor is studying the alternatives and there is a possibility that a private contractor will be hired to complete the decontamination process.

The parking lot downwind of the transformer is cleaned up by workers.

Workers unload empty drums which are used to contain contaminated items.

With all of these problems and costs associated with the cleanup, it makes good sense to replace all PCB electrical equipment. It had been estimated that it would cost approximately $11 million to replace all of the PCB electrical equipment at the Pearl Harbor naval base. The monies that the Navy lost as a result of this incident could have been used to fund a substantial portion of that replacement. From a public relations standpoint, replacement would have been made on a positive note, while this incident has attracted unwanted media attention for the Navy in Hawaii.

No one wants an incident involving PCBs to occur. The fluids of all electrical equipment at your activity should be tested to determine if they contain PCBs. If PCB concentrations 50 ppm or greater are identified, a risk analysis should be performed on each item and projects should be developed to have the equipment replaced.

All items identified as high risk should be replaced by the most expedient means possible. The definition of high risk will vary with the circumstances at your activity. Any cognizant engineering field division can provide guidance on this matter.

Replacement of PCB equipment not only prevents the occurrence of an incident but also eliminates the need to comply with numerous EPA and Navy record-keeping and inspection requirements for PCB equipment that remain in service. At installations with large numbers of PCB equipment, replacement can annually save as many as one to two manyears. □

NCEL scientists support Navy's readiness posture

By JERRY THOMAS
Public Affairs Office
Naval Civil Engineering Laboratory
Port Hueneme, Calif.

Chemist Dan Zarate conducts tests on a Fourier Transform infrared Spectrophotometer.

Nathalie Milliken, physical science technician, operates a tensile strength tester.

Metallurgist Dan Polly has developed a unique method to assess the condition of reinforcing steel in underwater concrete.

They are summoned into courts of law, testifying as expert witnesses for the Navy.

They provide direct assistance to Navy installations, solving field problems and saving taxpayers millions of dollars annually.

They adapt existing and emerging technologies, improving support to the Navy's shore activities.

These facilities are a vital link to maritime strategy.

They are conducting basic chemical research that could lead to the development of pigments for a "chameleon" paint, an energy-saving coating that would absorb heat and reflect sunlight.

"They" are the 19 professionals in the Materials Science Division, Shore Facilities Department, Naval Civil Engineering Laboratory (NCEL), Port Hueneme, Calif. Drawing upon approximately 240 years of experience in the application of materials technology, and with 35 patents issued over the past 10 years, the division's personnel represent a wide range of disciplines. These include chemistry, metallurgy, materials engineering, biology, corrosion engineering, composite materials, protective coatings, concrete technology, and cathodic protection.

As the sole laboratory under the Naval Facilities Engineering Command, NCEL is charged with the development and execution of a viable Shore Facilities Program. The work of the Materials Science Division forms an integral part of the Navy's constant fight to prevent deterioration and to maintain the readiness posture of its extensive and diversified shore facilities.

These facilities are a vital link in the Navy's efforts to implement its maritime strategy. The Navy is spending about $1 billion a year to protect these facilities (100,000 structures and buildings) spread over almost four million acres worldwide.

Accordingly, the staff specializes in coatings, composite materials, roofing materials, adhesives, corrosion control, marine and thermal concrete, and biological control of timber pilings.

Division Director Donald E. Brunner said his group has the talent, experience, and facilities to help resolve materials-related issues. The division serves the Naval Shore Establishment in three distinct areas: research and development of new or improved capabilities to support future Navy missions, adaptation of current or recent technology to today's needs, and immediate direct assistance in solving unique problems.

For example, the division recently formed a team (materials engineer, metallurgist, materials technician, and structural engineer) to inspect and evaluate 12 buildings constructed under emergency conditions during World War II at the Naval Air Station, Bermuda. The team's findings and recommendations will enable the Station to allocate appropriate funds for a practical and economical program of construction and maintenance. As a result, maximum fleet support is achieved at minimum cost.

During court hearings involving Naval Air Station, Jacksonville, Fla., NCEL paint experts provided convincing analytical data to support the Navy's contention that a private firm under contract should not receive an additional $100,000 for committed work.

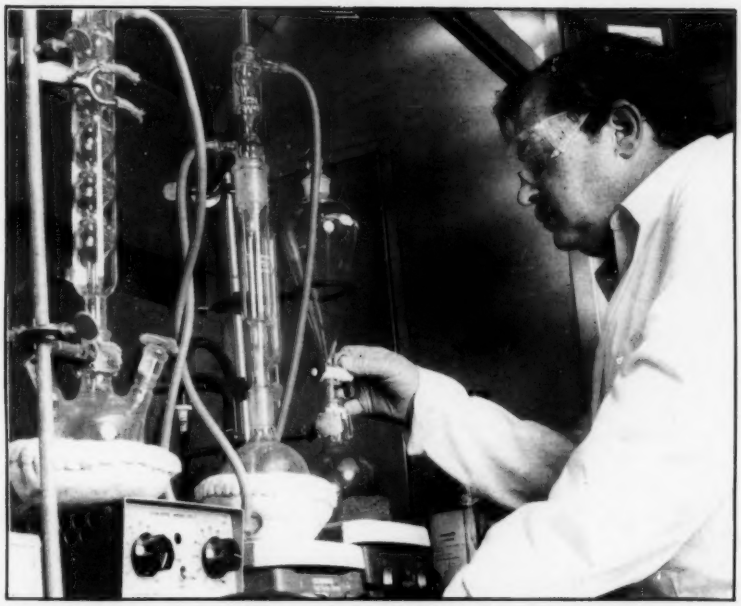
Two current research efforts could lead to technological breakthroughs.

Concerned with the near future, the division is evaluating commercially available superplasticizers that make concrete stronger and more durable. When these chemical compounds are mixed with cement and water, the workability of the concrete is improved and a lower water-to-cement ratio is needed. Less water in the mix produces a stronger concrete.

As part of a Navywide program to control corrosion of underground utilities, the Laboratory is preparing instructions for the design, maintenance, operation, and testing of cathodic protection systems. This contribution will significantly reduce corrosion failures of such utilities.

Brunner cites two current research efforts that could lead to technological breakthroughs with potential benefit to the Navy and the private sector.

Since 1985, NCEL has collaborated with the Los Alamos National Laboratory, N.M., and the University of California at Los Angeles and Santa Barbara on chemical research of pigments that change color, hence optical properties, as a function of solar heat (thermochromic) or light (photochromic).



Chemist Dr. Thomas Novinson performs organic synthesis and polymer chemistry in fume cabinet. The vial at left reflexes solutions.

If successful, these pigments could be added to an exterior paint to absorb heat in the winter and reflect it in the summer. Such a coating could reduce substantially the cost for heating and air conditioning fuel.

In the second research effort, Laboratory chemists last year identified new metallic salts that cause rapid setting of ordinary concrete. This discovery could prove important because wet concrete normally takes two and a half hours to set and approximately 30 days to achieve full strength.

Rapid-set agents for concrete are commercially available but they generate increased corrosion of the steel used to reinforce the concrete. The NCEL compounds appear to be non corrosive. They are capable of controlling setting times, some as rapidly as two minutes.

The Laboratory has filed a patent application but commercial development is still a few years off. Additional research must be conducted to determine if the salts have any other effects on concrete.

Since its establishment in 1948, NCEL has been instrumental in providing the shore establishment with improved construction materials, protective coatings, and methods and systems to resist corrosion, thereby improving the ability of the shore establishment to support the operational arms of the Navy. □

Val Hernandez uses a resonant frequency tester to calculate dynamic modulus of elasticity of concrete.

advice of counsel

Maintaining order within the workplace and motivating employees to conform to acceptable standards of conduct are the principal reasons for taking disciplinary actions against employees. Immediately upon perceiving that an employee is a disciplinary problem, a supervisor should consult with the civilian personnel office and, as needed, the counsel's office to determine the appropriate actions to be considered.

In any employee action, the agency has to prove that it took appropriate action against the employee based on the evidence. Generally, this means that the agency must prove: (1) the occurrence of the underlying charge, (2) a nexus or connection between the charge and efficiency of the federal service, and (3) the appropriateness of the penalty.

On the other hand, the employee has to prove an affirmative defense to the agency action, such as handicap discrimination, harmful procedural error, or that the decision was not in accordance with the law.

There are several considerations that a supervisor must take into account when proposing or rendering a decision on a disciplinary action.

Supervisors must provide all relevant facts to the personnel office (or counsel's office) to ensure that a proper evaluation of the employee's disciplinary problem is made before recommending the appropriate course of action.

Discipline must not be arbitrary or capricious. It must be based on the character of the offense, the frequency of the same offense, or other incidents of misconduct. The supervisor must consider mitigating factors presented by the employee.

A basic tenet of discipline is: "Like penalties for similar offenses." Case law in the disciplinary area has imposed an affirmative duty on management to consider mitigating and aggravating factors, known as the "Douglas" factors, when arriving at a decision as to the appropriateness of the penalty. For example:

- The nature and seriousness of the offense, and its relation to the employee's duties, position, and responsibilities.
- The employee's job level, contacts with the public, and prominence of the position.
- The employee's past disciplinary record.
- The employee's past work record including length of service, performance on the job, and ability to get along with fellow employees.
- The effect of the offense upon the employee's ability to perform at a satisfactory level and its effect upon supervisor's confidence in the employee's ability to perform assigned duties.
- The notoriety of the offense or its impact upon the reputation of the agency.
- Potential for the employee's rehabilitation.

A well-prepared and documented action will not only facilitate a legal defense of the action, should it be appealed, but will also ensure fairness and "due process" is provided to the disciplined employee.

Anchors at CBC Museum stir 'deep' mystery

The CEC/Seabee Museum at Port Hueneme, Calif., has on display two large anchors that were formerly displayed in the quadrangle along with unit plaques on the island of Diego Garcia.

Anyone having information on where these anchors came from, please contact Museum Director Hark Ketels by telephoning (805) 982-5163. Were they dredged up? Located by underwater diver? Found on the Island? What ship are they from? If you know the answer, please call! Or write to CEC/ Seabee Museum, CBC Port Hueneme, CA 93043.

Contracting government services out: A growing problem or growing solution?

By RICHARD E. CHITTENDEN
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Naval Facilities Contracts Training Center
Port Hueneme, Calif.

It's time to examine our government's growing committment to acquire a large variety of services and support for naval activities from private-sector vendors services formerly performed by Navy employees. Under direction from the Office of Management and Budget (OMB), the federal government must allow private enterpreneurs to compete openly to provide these services, commonly known as commercial activities (CA). The OMB titled their directive Circular A-76, *Policies for Acquiring Commercial or Industrial Products Needed by the Government.*

The outgrowth of A-76, the facility support contract (FSC), will be examined and put into perspective with respect to its main competitor for talent in the contracting arena — Military Construction (MILCON). The quality assurance (QA) organization at each naval activity is a key and, until now, an overlooked factor in the success or failure of FSCs in providing an ever-widening menu of services to the Navy.

Considered also, will be the people who deal daily with the service contractors on their own turf, accepting or rejecting a continuous stream of work, applying a variety of inspection techniques to a growing variety of services, and providing the all-important documentation to protect the Navy's interests.

Also discussed will be some aspects of the growing role of training in pulling together this expanding method of doing business by injecting uniformity, pride, and quality into the services produced . . . and received.

"Smokestack America is dead!" and "America is now service economy!" may be overplayed slogans, but there is no doubt that new emphasis is being placed on service by Americans. We expect more. We compare quality of service or product with that of other countries; i.e., an airline or automobile.

Perhaps the government has entered a new era of its own, a "service economy" based on OMB Circular A-76 and the proposition that many traditional in-house services might be better, or more cheaply (or both) provided by contracts with the private sector.

Issued by the old Bureau of the Budget (now OMB) in March 1966 under the Johnson administration, A-76 was first implemented during the Nixon years. Despite an instruction by the Secretary of the Navy in early 1970, only in the past decade have we seen real growth in our contracting for facility support. Reacting to the need for guidance in managing this relatively new form of contracting, Naval Facilities Engineering Command (NAVFAC) sponsored development of a course of study at the Naval School, Civil Engineer Corps Officers (CECOS).

Based on a study of support contracting at Mare Island Naval Shipyard, Calif., the Service Contract Course debuted in early 1979. The learning process continues. As contracting out spreads through the Navy and other federal departments, either in compliance with A-76 or simply as a business decision in response to manpower and fiscal constraints, not all people see it in the same light. Is it a growing problem or a growing solution?

Point of view is important. Has the government been doing a job the private sector should be doing? Which can do it cheaper, better? Whose job is being lost when public works functions are contracted out? Are new jobs created? How does this affect the local or regional economy? What about taxes? What happens in a contingency? Is the Navy's responsiveness, flexibility, or security reduced or enhanced? Can we effectively manage our growing volume of contracted service and support?

Economics and political philosophy were both "brought to bear," first on the original drafting of A-76, again in the renewed emphasis on its implementation. But from the point of view of the typical fleet commander, activity commanding officer (CO), or public works officer (PWO), the choice should be simple: How do I get (or give) the necessary fleet support within a realistic budget?

Traditionally many of us, both in and out of uniform, have grown to think of the MILCON program as the hallmark of success when it comes to supporting the floating and flying Navy. We have all heard of the resource sponsors who programmed billions of dollars for weapon systems and who felt that more funding in new shore facilities was sufficient support for those systems. And we have known the activity CO who sometime felt a major accomplishment was to leave a new hangar, pier, or other facility as a monument to management skills.

The PWO, faced with reality of growing maintenance and repair backlogs and level operating and maintenance dollars, copes with the familiar "catch 22" of trying to support the CO's MILCON appetite while keeping existing facilities operating acceptably.

In recent years, major claimants have come a long way toward narrowing the gap by putting more money into replacing aged facilities, showing awareness of the need for

maintenance. Now, like it or not, they and their activity COs are being led (or pushed) into a new way of operating — having someone else (our facility support contractors) do for them what they used to do for themselves.

Point of view will be critical in how they and their staffs accept the change and whether they support and eventually optimize it. Remember too that the quality of the support received by the ultimate customer, say a fleet commander, will be increasingly dependent upon support contractors. But that commander will continue to look to the activity CO and the PWO for satisfaction.

There is political glamor for a congressman associated with announcing each year's MILCON program in the local district. That's hard to match with an announcement of increased volume of support contracts and the number of jobs created (in the private sector) or lost (by civil servants), depending on where the politician thinks the votes are strongest.

There is strong public support for letting private enterprise do what civil servants have traditionally done.

From our side, we won't see our engineering field division (EFD) commander and assorted politicians, designers, etc. with the ceremonial shovel at the groundbreaking of a new support contract. There will be no ceremonial ribbon cutting at contract completion. The support contract is never completed. It is only renewed, refined, or re-bid. It faces a challenging future.

Barring major political or philosophical shifts with regard to how our support is provided, the future is now. The figure on page 11 shows the trend in dollar volume of our FSCs. When compared to the Navy's MILCON program in recent years, it is clear that facility support contracting is coming of age. Also remember that MILCON fluctuates in response to many pressures and is probably more politically vulnerable than is the growing FSC program. There is a strong and rising underpinning of public support for letting private enterprise do what civil servants have traditionally done.

But as with many programs, especially in the public sector, the statutory mandate to proceed often outpaces the regulatory ability to provide dollars, people, and the managerial skills to fully realize the original goals at an acceptable level of quality. This program is no exception.

Our contracting organization, from NAVFAC headquarters down through our EFDs to the activities, has been tested by an explosion of new contract volume. It has been overlaid on the traditional construction and architect-engineer (A-E) workload. It demands expertise in forms of contract administration and management which were used on a smaller scale. And even as we congratulate ourselves on our growing ability to prepare more sophisticated support contracts, major problems persist.

As we rush to contract out services because we can no longer staff them or because we are mandated to do so by continuing CA studies, we may find a shortage of competent contractors willing or able to bid for our service business. We may also find that Navy personnel tasked with providing oversight of these services to ensure quality are either underqualified by experience or training or simply not available in sufficient numbers.

We are now faced with a new breed, the person who carries out the day-to-day inspection (surveillance in their trade) to ensure compliance with requirements of our FSCs. They are parallel in many ways to the familiar construction representative (CONREP) on construction and repair projects. Known in the trade as quality assurance evaluators (QAEs) or contract surveillance representatives (CSRs), they must cope with problems never considered before by the CONREP.

Even on a support contract covering a single function, such as the traditional janitorial service or grounds maintenance, the work is not confined to a single convenient construction site. It may cover 300 buildings on a 2,000-acre naval air station, or 800 buildings on a 250-square-mile Marine Corps base.

Unlike a well-scheduled concrete pour, structural steel erection, or major equipment installation, the QAE is asked to provide surveillance of operations carried out continuously, by many contractor personnel in multiple buildings or on various sites daily.

When are the windows, the floors, the carpets clean? How clean? By what standard? Is the grass really less than three inches high? How to measure and how often? It all becomes more complex as an ever-increasing number of functions are contracted out. The complexity is compounded as the multi-function contract is awarded, requiring many skills on the part of both contractor and Navy QAE.

Clearly, many technical and administrative problems can be mitigated by improving the form and quality of our contracts and by selection of qualified contractors. But this still doesn't solve all the problems of our most visible people in the FSC business — the QAEs.

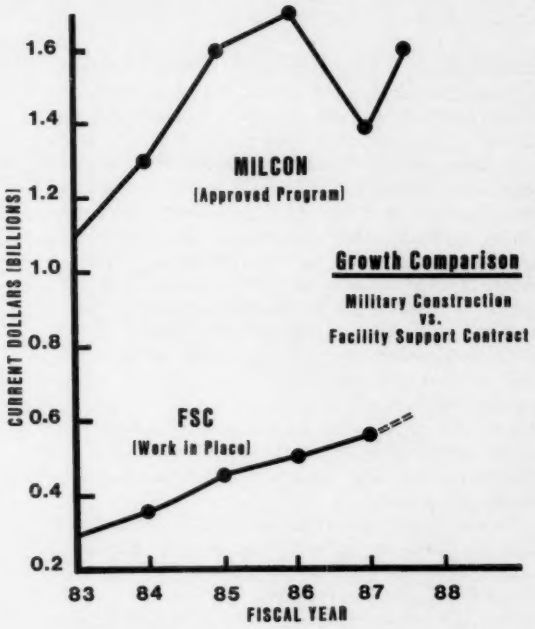
When the chips are down, the average QAE will tell you that his/her major problems are a relative few: understaffing, inadequate transportation to cover large or multiple areas, inability to obtain the computer equipment and programs to handle more complex sampling techniques, maybe the need for more training to qualify for a growing variety of functions inspected, and a frequent lack of support from the chain of command.

The QAE may resent — rightfully — the complexity, ambiguity, and conflicts seen in many first-generation contracts. But the EFDs and NAVFAC are making great strides to correct these in concert with facility support contract managers (FSCMs) and officers in charge (OICs) in the field.

In addition, the EFDs are developing a growing number of training opportunities, both homegrown or provided by other agencies, to improve the surveillance and management skills of our QAEs, FSCMs, and even the OICs and some PWOs. Minimum training standards have been developed for QAEs and for other players in the game. The training courses are there and are improving in quality, diversity, and quantity each year.

The Naval Facilities Contracts Training Center (NFCTC) is developing textbooks for use in these courses. A new quality assurance department at the Center in conjunction with NAVFAC is examining the proposition of injecting additional quality into the business of facility support contracting, using QAE training as a starting point.

NAVFAC has strong commitment to quality in all forms of contracting. The quality assurance division was established in August of 1985 with a branch dedicated specifically to FSC. Less known is the role of the NFCTC at Port Hueneme, Calif. Courses are offered world-wide in all facets of contracting for the acquisition and operation of naval facilities. A common element of these courses is a growing emphasis on quality of services, facilities, and operations.



Although a segment on quality assurance (QA) or quality control (QC) is included in many NFCTC and CECOS courses, there is no separate course on QA required for the warranting of contracting officers. Recent changes in NAVFAC's Contracting Manual P-68 require minimum mandatory training for individuals in QA-related positions. Little or nothing appears in the procurement regulations (FAR, DFARS, NARSUP) that tailor the application of QA and QC to our types of procurement (construction, A-E, FSC, etc.). The emphasis therein is definitely on supplies and weapon systems.

Training can be a reward as well as an essential part of any quality program. It should not be limited only to providing systems, methods, instructions, data-gathering, and analysis aimed at increasing productivity and lowering costs (i.e., the old industrialized approach). We must also train to change attitudes, provide motivation, question the status quo, make quality part of the product or service, and make us realize that quality will yield productivity, customer satisfaction, lower operating costs, and — the final objective — reliability of the service or facility provided. This is validated by the classic caveat that we must learn not only to "do things right" but to "do the right things."

But in spite of all this, the best-trained QAE with a good contract and a responsive contractor may still be unable to perform without the full and enthusiastic support of the activity CO. First, the CO must understand and at least nominally accept the new culture of contracting out, of having key services provided by people no longer in the command, in many cases not as responsive to his or her perceived needs. Second, is the need to understand the importance to the readiness of the activity of the continued high-quality delivery of these services. Next, the CO must understand the importance of the QAE who helps guarantee the delivery and the success of the entire contracting process.

The EFD may write the contract or help the activity to do so. It may establish criteria for quality, provide the training, and perform staffing studies to help justify adequate QAE billets. It is also true that OPNAV instruction requires the activity served to furnish adequate QA staff. NAVFAC policy directs the contracting officer to confirm that adequacy before advertising the contract.

At many activities, staffing levels have been mandated by archaic formulas originating from old CA studies. But only the COs can make it happen. They must hire the QAEs, allow time for training, and give them support. They should also realize that continued quality performance by the these people can be enhanced by a well-designed system of incentive awards, both monetary and nonmonetary. Little has been done in this area to date.

If we are to be successful in our search for quality contract services, we must seek improvement on both sides of the equation. We must provide professional contract documents, administration, and surveillance and elicit quality performance and products from our contractors. It is hard enough to "sell" quality to corporate America. But the rewards can be great: profits, more customers, increased market share.

Instilling the quality mystique is more difficult on the government side of the house. We can help it along with *mandatory programs* (quality control requirements, strict surveillance, penalties for unsatisfactory performance) and *discretionary programs* (innovative evaluation methods, recognition, incentives for high performance). We have no corporate profit motive. We are limited in the use of personal recognition, rewards, or celebration so effective in many of today's excellent corporations. Our customer decides what service to "buy," our contracting organization decides how to make the buy, and from whom. A third party (the contractor) provides the service.

We must work harder at involving employees in any quality management system and in maintaining their interest. The team that manages the systems includes everyone from user to contract administrator, specification writer, contract manager, QAE, activity commander, and more. Think of providing a service as a continuum, from identification of need to delivery and use or operation. Each player in the chain is providing a product or service to his or her "customer," the next person or group in line.

As the individual players take pride in the success of their part of the game, the satisfaction of their "customers," the overall process must succeed. The EFD furnishes a fair and equitable contract, the activity provides professional management, the activity CO backs their QAEs and ensures training, recognition, and professional growth is provided. Given the ability to perform, the contractor inevitably will respond to quality management with quality services. □

67-year-old Pier J/K at NAS North Island gets major overhaul

By CDR RICHARD L. STEINBRUGGE
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P.E., Calif. and Oregon
Staff Civil Engineer
NAS North Island, Calif.

After 65 years of service, Pier Juliet/Kilo (J/K) at Naval Air Station (NAS) North Island has structurally deteriorated to near collapse, severe load limits have been imposed with only pedestrian and light vehicle traffic permitted on the pier.

The conventional solution might have been abandonment in place and/or a replacement pier obtained through the Military Construction (MILCON) program. Instead, the major claimant, Commander in Chief, U.S. Pacific Fleet (CINCPACFLT) elected to support a major refurbishment of Pier J/K executed through the facilities special project program.

The success of this approach demonstrates the potential of the Chief of Naval Operations (CNO) Shore Facilities Life Extension Program (Shore FLEP).

Initial construction of of Pier J/K commenced in 1921 with the first ship docking in 1922. In 1930 the pier was lengthened with new berthing space added to each end. A small addition in 1958 widened the pier to its present dimensions.

Until nearly the end of World War II, Pier J/K served as the only NAS North Island docking facility for capital ships. It provided a vital link between developing naval aviation at North Island and the fleet. The Navy's first aircraft carrier, *USS Langley,* was homeported there for ten years.

During World War II, carriers were loaded with aircraft at Pier J/K before steaming into battle in the Pacific. Although the pier is not large enough for modern aircraft carriers, it has continued to provide important deep draft berthing for the surface fleet. *USS Long Beach* (CGN-9), and cruisers of the *Ticonderoga* class (CG-47) have routinely tied up at Pier J/K.

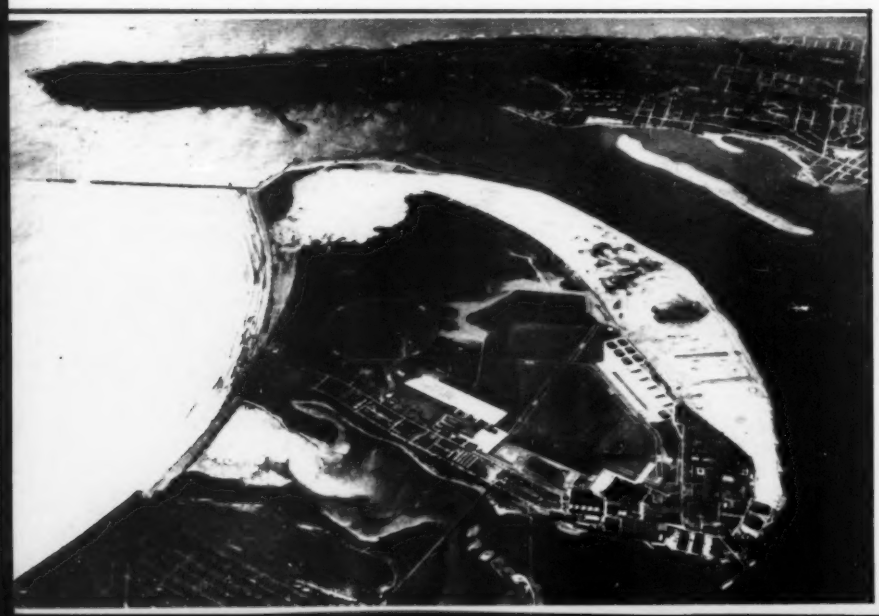
Concern about the structural condition of Pier J/K began several years ago. The 1921 and 1930 construction (Regions A and B) used Type I cement in conventionally reinforced square concrete piling. A chemical reaction between sulfate ions in seawater and Type I cement resulted in softening of the concrete. Type II cement, resistant to this deterioration, was not readily available on the West Coast until after 1940.

Detailed underwater investigations were begun in 1981 by Chesapeake Division's (Naval Facilities Engineering Command) Ocean Engineering and Construction Office. This study confirmed that severe deterioration of the piling in Regions A and B had occurred. Much of the concrete had virtually "rotted" away leaving vertical reinforcing steel exposed.

In some cases, the concrete erosion had penetrated the piling sufficiently to permit the investigator's hand to pass behind a vertical reinforcing bar (between bar and "confined" concrete in the pile).

The 1981 report estimated that the piles in Regions A and B had lost over 50 percent of their bearing capacity before taking into account slenderness reductions.

The piling in Region C (1958 addition), constructed using Type II cement, were found to be in excellent condition. Unfortunately Region C represents only 12 per-



Aerial view of North Island in 1939. New 1930 additions to Pier J/K (lower right) are lighter in color and clearly visible. Fill has expanded the western shoreline.

The photos on pages 12 and 13 are not up to our usual quality because of their vintage.

cent of the total pier area.

Further studies recommended elimination of vertical Live loads except for pedestrians and light vehicles. It was suggested that Pier J/K was approaching the end of its useful life for all but small craft berthing loads.

Determining that the pier remained a crucial West Coast berthing asset, CINCPACFLT decided to fund a major refurbishment project with maintenance and repair (MRP) funds. A $9.7 million facilities repair special project was developed and scoped to include new prestressed concrete piling, strengthening of the deck, and replacement of utilities. Advantages of this alternative over MILCON for a new pier are fundamentally cost avoidance and more rapid programming and execution.

1. CINCPACFLT was able to make the final decision to fund the project based upon economics and mission requirements (subject only to concurrence from Assistant Secretary of the Navy (ASN S&L) since the project exceeded $3 million).
2. Although new piling will be driven from a floating rig, the existing pier deck will nevertheless serve as a useful construction platform for much of the work.
3. Demolition of the old pier is avoided since it will be incorporated into the new structure.
4. An existing energy-absorbing fender system, which is in good condition, will be reused.
5. Repair costs will be less than 40 percent of the estimated facility replacement cost.

Project design was accomplished by the structural engineering firm of Travis, Verdugo, Curry and Associates of San Diego. Changes in the original repair approach were recommended by the firm during design. Adoption of these changes reduced the estimated cost by $2 million, and resolved the potential repair versus construction (i.e., total facility replacement) dilemma by incorporating the existing pier deck into the new structural system.

On August 27 1987, Western Division, Naval Facilities Engineering Command awarded the repair contract to General Construction Company of Seattle, Wash.

Parachute practice over Pier J/K and the USS Langley in 1926.

Work started in October 1987 and is expected to be concluded in 18 months.

The refurbished pier will be capable of supporting a 70-ton mobile crane, providing cold iron utilities for either the *USS Long Beach* or simultaneously for two nested CG-47 class cruisers. Its berthing strength restored, Pier J/K will safely dock the *Long Beach* plus two CG-47 class vessels nested outboard. The structural integrity of Pier J/K will be extended indefinitely.

Shore FLEP Expanded—A Personal View

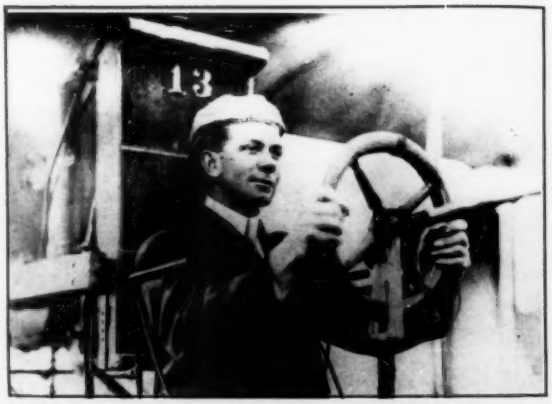
In 1986, a message from the Chief of Naval Operations outlined a three-part program:

1. Prioritization of facility investment categories
2. Expansion of the shore base readiness report
3. Establishment of program goals in replacement/modernization (R/M) MILCON and MRP categories.

To make the program fully effective, work is needed in the MRP category, banking heavily on MILCON contradicts history. Based upon the R/M MILCON track record, it has been estimated that Pacific Fleet air station facilities must survive a 760-year replacement cycle! Resource sponsors must be convinced to program more dollars into MRP, particularly to support large Shore FLEP projects funded at the major claimant level.

Also, an adjustment is needed of the repair versus alteration rules. Refurbishment of an existing permanent facility which becomes necessary due to deterioration, wear and tear, safety or geometric deficiencies, where no fundamental change in the use of the facility is involved, should be classifiable as repair. Associated work to bring the facility up to modern standards should also be considered repair.

The principal test whether to refurbish or replace a facility should be an economic comparison. Today, much of the work that needs to be done under Shore FLEP is categorized as alteration which often limits what can be executed below MILCON scope with MRP resources. □



Known as the "birthplace of naval aviation," North island was the site where Lt. T. G. Ellyson, Naval Aviator Number One, received flight training from Glenn Curtiss in 1911.

instructor in the spotlight

LCdr. Denny Fewell

Naval Facilities Contracts Training Center
Port Hueneme, Calif.
Specialty: Contracts Management

LCdr. Denny Fewell joined the Naval Facilities Contracts Training Center (NFCTC) in June 1986 during the Center's first year of operations at the Naval Construction Battalion Center (NCBC), Port Hueneme, Calif. LCdr. Fewell's extensive experience gained through his prior public works and contracts duty assignments has greatly contributed to the development and presentation of course material. He has served as the course administrator and primary instructor for two of NFCTC's courses.

Initially, he was assigned the Facility Support Contracting (FSC) course, designed to provide training to Naval Facilities Engineering Command (NAVFAC) personnel in the expanding area of facility services contracting.

He also provided direct technical assistance to various field activities in FSC matters. In December 1986, he was reassigned to the Advanced Contract Management course, which is targeted toward intermediate-level personnel involved in construction contract administration and management.

LCdr. Fewell has made significant improvements to this Department of Defense (DoD) mandatory acquisition training course using his first-hand field experience and real-world/NAVFAC case studies to reinforce the course material. Both courses are required under the NAVFAC contracting officer warrant program.

LCdr. Fewell received his commission in 1976 through the Naval Officer Candidate School in Newport, R.I. His previous duty assignments include public works tours at NAS Moffett Field, Calif., and PWC Subic Bay, R.P.; and Assistant Resident Officer in Charge of Construction tours at MCAS Beaufort, S.C., and NAVSUBASE Bangor, Wash.

He holds a Bachelor of Science degree in Architectural Engineering from the University of Colorado and a Master of Science Engineering degree from the University of Washington. He is a registered Professional Engineer in the state of Washington.

LCdr. Fewell and his wife, Sandy, have one child. They reside aboard CBC Port Hueneme, Calif.

When he isn't traveling to present a course, he is active in a local PTA, golfing, and playing racquetball. He also recently restored a 1966 Ford Mustang convertible.

The Naval Facilities Contracts Training Center (NFCTC), Port Hueneme, Calif., provides specialized training in construction, design, and facility support contracting administration to NAVFAC civilian procurement personnel and Civil Engineer Corps officers. This training is provided to enhance the professional knowledge and capabilities of our procurement personnel to meet the challenges of managing a contract workload which is growing in volume and complexity, satisfy DoD-mandated acquisition training requirements, and to support NAVFAC contracting officer warranting requirements.

This fiscal year, NFCTC will provide 10 one- and two-week courses through 95 individual course offerings at locations throughout the United States and at selected overseas locations. It is expected that approximately 4,300 training completion certificates will be issued.

In addition, NFCTC maintains the NAVFAC procurement training database which records the completion of all acquisition-related training to track the progress of training within NAVFAC; is used in the development of individual training plans, forecasts future training needs, and verifies qualifications of procurement personnel and contracting officers.

New facility at Port Hueneme to save Navy $300,000 annually

By JERRY THOMAS
Public Affairs Office
Naval Civil Engineering Laboratory
Port Hueneme, Calif.

Construction started in the fall of 1987 on the Navy's first gas turbine cogeneration system with a waste heat recovery boiler that produces electrical and steam (thermal) energy simultaneously.

The 800-kw plant is being installed at the Naval Construction Battalion Center (NCBC), Port Hueneme, Calif., where an aging boiler system is no longer efficient.

Financed solely by the Navy, the $2.7 million site-specific facility should be operational within 14 to 18 months. The plant will capture exhaust heat (approximately 900° F. temperature) escaping from the turbine and direct it to the boiler to generate steam at a rate of 6,500 lbs./hr. Additional steam (23,000 lbs./hr.) will be supplied by a supplemental boiler fueled by natural gas.

Scientists at the Naval Civil Engineering Laboratory (NCEL), Port Hueneme, the Department of Defense's principal investigator for cogeneration research and development, said the new facility will supply about 10 percent of electrical and thermal power needed by the complex of 10,000 military and civilian employees. Additional electricity will be purchased from Southern California Edison Co., a commercial utility company. Presently, the base generates no electrical power.

NCEL Cogeneration Project Engineer Dr. T. Richard Lee said when the NCBC 800-kw gas turbine is on line, the Center should realize an approximate annual savings of $300,000. A simple payback period of four years is forecast.

Lee said steam requirements today at NCBC are met by one of three identical boilers at the Thomas heating plant. Built in 1953, the boilers are in unsatisfactory operating condition and should be replaced as soon as possible. The base's Public Works Department estimates that 53,000 MBtu a year are lost because of low operating efficiency and stack losses.

Why did the Navy select this system for installation over 10 other cogeneration options proposed for NCBC? A 1982 feasibility study originally recommended a cogeneration system of three 500-kw gas turbines and heat recovery boilers. Subsequent evaluations, including studies using the comprehensive computer-based Civil Engineering Laboratory Cogeneration Analysis Program (CELCAP), determined that the 800-kw plant would achieve optimum economic and engine performance benefits. Lee said the system best matches the Center's electrical and thermal needs.

CELCAP is a preliminary design and evaluation screening tool that helps decide which system is best for a particular site. The program evaluates performances of various cogeneration configurations, compares benefits and costs, and then recommends one configuration for installation.

Lee said CELCAP recommended a gas turbine cogeneration system for several reasons. First, the gas turbine was cited for its simplicity and reliability of performance. It requires substantially less maintenance and overhaul than a diesel engine system. A gas turbine unit is quiet, permits true unattended operations, and puts out fewer pollutants. Combustion is remarkably complete with little carbon monoxide or hydrocarbons reaching the exhaust.

Since its development, NCEL's CELCAP program also has proven to be a valuable economic tool. The program has played an integral role in feasibility studies conducted at more than 20 Navy and Marine Corps facilities. The average cost of an in-depth cogeneration study using CELCAP is $35,000. In comparison, the same study not using CELCAP costs approximately $100,000. Thus, the Navy saved about $1.5 million during a five-year study of sites considered for cogeneration.

The Western Division of the Naval Facilities Engineering Command, NCEL's principal sponsor, was responsible for engineering design and contract award. The Division said the Navy has the option to construct a second 800-kw gas turbine at Port Hueneme within three years, depending upon the performance of the unit under construction.

By financing and owning its own cogeneration system, the Navy gains all ensuing economic benefits. Lee said outright ownership of the NCBC plant, built with military construction funds, enables the Navy to generate required energy at less cost.

The Navy's Cogeneration Program has identified major bases where the system would be economically feasible. It's estimated that Navywide application of cogeneration would reduce utility costs as much as $300 million a year. The Department of Energy, supporting this significant energy-saving potential, said that by recapturing and using some of the waste energy normally discharged from an engine, a cogeneration system can reduce fuel requirements by 10 to 30 percent at a given site.

Increasing concern over the environment has caused developers of projects to exert more care to avoid a ...

LANDSLIDE

By PH1 JOHN M. BUFFALO
Assistant Public Affairs Officer
Reserve Naval Mobile Construction Battalion 16
Los Alamitos, Calif.

Thirty years ago a man stood looking out at the beautiful Pacific Ocean and legendary Catalina Island from the veranda of his expensive new home. By the time a quarter of a century had passed the view is still there but the man and his home are gone. The home is now rubble, the victim of a massive landslide which had been reactivated by the construction and excessive fluid from lawn watering which had been drawn into the overburden and strata.

This scenario actually occurred in Portuguese Bend, Palos Verdes Hills, Los Angeles County, Calif. This devastating slide is often used to show a classic slide and how man's actions are critical to what happened. It might happen anywhere that man has built in hillside or mountainous areas but it is especially critical since it occurred in a highly populated area.

An examination of the types and causes of landslides, and some methods for the prevention of slides or repair of their damage are presented. A number of conclusions will be drawn which will tie the information together.

TYPES AND CAUSES OF SLIDING

Landslides are the movement of overburden or rock from one point to another via gravity. There are a number of types of movement and a greater amount of causes.

Types of Sliding

Flows — A flow is the movement of a rock, soil, mud, or ice mass which individually or in combination with other substances has become liquified and descends a given slope with the assistance of gravity (Figure 1a).

Rock Falls — Where major masses of the mountainside which have become weakened by excessive weathering or seismic activity and the material is moved downslope via the processes of gravity (Figure 1b).

Soil Creep — A condition in which there is a gradual downslope movement of the soil overburden to level ground. Movement in this form of slide is slow and usually measured in terms of centimeters rather than meters (Figure 1c).

Slumping — A slump is similar to the soil creep in appearance but usually involves rock as well as soil and contains some rotational movement along the rupture (Figure 1d).

Tortional/Rotational Sliding — The traditional classic block-glide slide. It is usually massive and primarily of bedrock which has failed along a bedding weakness or from lack of support. There is distinct regular movement which can be measured in meters, and it is easily recognizable due to its pattern of breaking into distinct blocks. Intermediate slumping and formation of compression ridges is often associated with this type of slide. Slides such as this are especially devastating in populated areas (Figure 1e).

Causes of Sliding

There are many causes of landslides and many other activities which can trigger sliding, some are manmade and some are natural in occurrence.

Natural Causes — Natural triggers for landsliding have been around as long as the earth has been in existence. They have had a greater effect upon man as he has gravitated toward more hillside construction. What follows is a partial listing of the more common types of triggering mechanisms that occur in nature.

Seismic — Most mountain building has attendant faulting and many of these faults present surface rupturing. At various points along the fault, trace sliding may be initiated when the seismic movement occurs. This was one of the key reasons for the large loss of life during the 1959 Madison Canyon earthquake. In this slide a buttress of dolomite which had formed the natural support for the cliff was destroyed by the seismic activity. The removal of the buttress destabilized the near vertical cliff and sent 80 million tons of material crashing down into the canyon below. Among other damage, the slide mass landed upon the Rock Creek Campground instantly killing 19 persons (Figure 2).

Volcanic — The inherently violent nature of volcanism causes ash and rock falls, pyroclastic ejection, mudflows, and translational/rotational sliding as well as fringe slumping. As was seen in the cases of Mt. Lassen in 1915 and Mt. St. Helens in 1982 the meltdown of summit glaciers can initiate massive mudflows that in addition to the destruction of millions of board feet of timber caused the demise of a number of persons who were unfortunate enough to be caught in them (Figure 3).

Weathering Extremes — Constant changes in humidity and temperature can weaken slope faces and cause rock falls and other slides.

Weather-Caused — As opposed to extremes in weathering which occur over a period of years, extremes in weather conditions can render a slope unstable and cause failure in a matter of hours. Usually what occurs is that the toe support is washed away or the volume of precipitation exceeds the ability of the rock to support the saturated material. When a rain-soaked slope such as the Love Creek in Santa Cruz County, Calif., becomes

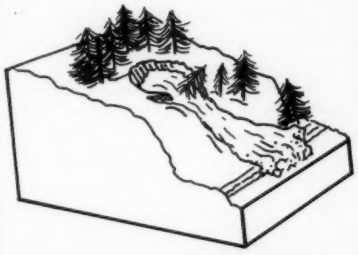


Figure 1a.
Mud or debris flow

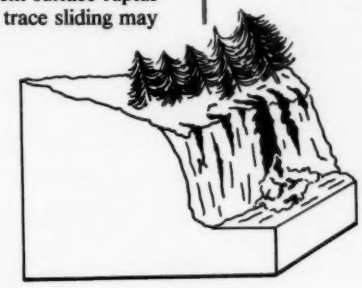


Figure 1b.
Rockfall

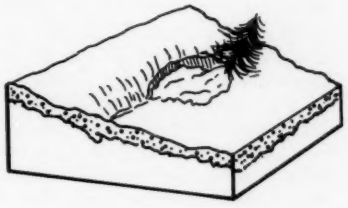


Figure 1c.
Soil creep on shallow slope

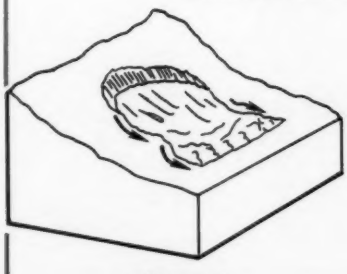


Figure 1d.
Slump of soil and rock

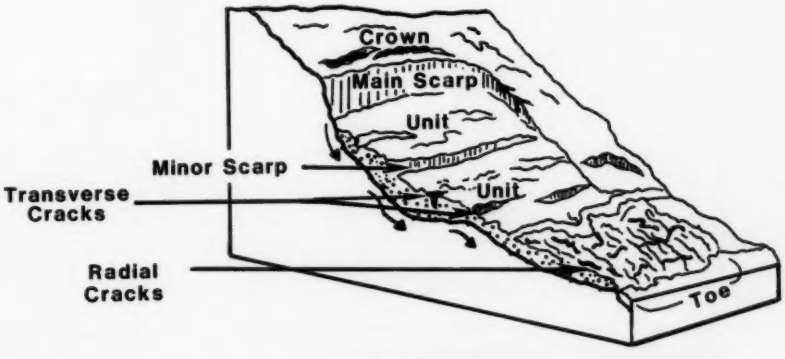


Figure 1e. Tranlational/rotational slide.

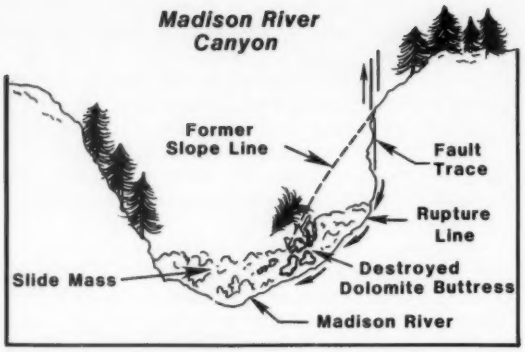


Figure 2. Slide initiated by seismic activity in the 1959 Yellowstone/Montana earthquake. Slide mass is 80+ million tons in volume.

oversaturated, then it fails destroying everything in its path. In this case 10 lives were lost with the large amount of property that was destroyed (Figure 4).

Man-Caused — When discussing man-caused sliding it must be understood first and foremost that man is his own worst enemy especially when it comes to dealing with the forces of nature. Some of his mistakes are honest ones made through ignorance but others are made through negligence or greed.

Geologic Conditions — One of the easiest areas for man to eliminate problems is to know the geologic conditions of a site before development. When ignored the results can be disasterous. For example, the Portuguese Bend Slide that was described earlier was built on a pre-existing slide of mammoth proportions.

In the Portuguese Bend Slide, the slide had been mapped in the early 1920s for the first time and was again mapped during World War II. Both of these surveys were available to the developer and to the county of Los Angeles. Permits were issued and homes were constructed upon the site. Almost as soon as the homes were complete and the regular watering of lawns started, movement began. The homes were destroyed and a flurry of lawsuits began. This slope has remained unstable since it first began to move in the mid-1950s because the Pacific Ocean regularly removes the support from the mass. At present, the slide moves several inches daily causing utilities to be placed above ground and the repair of the roadway on a regular basis. If the history of the site had been checked prior to development the problems which occurred could possibly have been prevented (Figure 5).

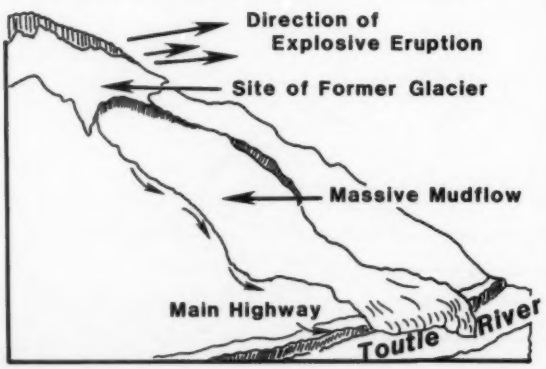


Figure 3. Massive mudflow caused by the glacier melt during the explosive eruption of Mt. St. Helens on May 18, 1982.

Improper Site Drainage — After a site is chosen for stability, the project is sometimes wiped out due to improper drainage. For example, a road cut is made and seems to be stable but no effort is made to set up a proper drainage pattern. An extreme amount of precipitation occurs during the wet season causing erosion which destabilizes the slope and it fails (Figure 6).

Slope Destabilization — When preparing a site for construction a careless developer, perhaps in a hurry, will sometimes allow the people to cut away the base of a slope. If the geologic conditions have not been checked, this action could then render the slope unstable. As soon as the extra weight of structures is placed upon the top or erosion is allowed on the slope from precipitation or watering of lawns the slope fails.

Overbuilding — Some slopes which have been stable at the beginning of construction become unstable and fail because the developer has overbuilt on the site and exceeded the ability of the strata to carry the increased load (Figure 7).

The causes presented are not the only ones, but are an examination of some of the more common ones.

POTENTIAL SOLUTIONS

Geologic Reports — One of the most useful tools available to the architect or project engineer during the initial stages of site selection is the geologic report. The reports can cover everything from the flora and fauna to detailed analysis of potential problems, and are available from such agencies as U.S. Geological Survey or state equivalents like the California Division of Mines and Geology.

All are available in libraries or for public purchase. A privately funded report or survey might be used instead

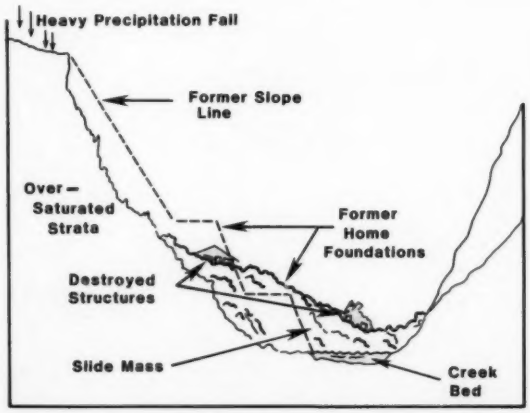


Figure 4. Slide caused from heavy flooding when a slope becomes oversaturated and fails, destroying any structure in its path.

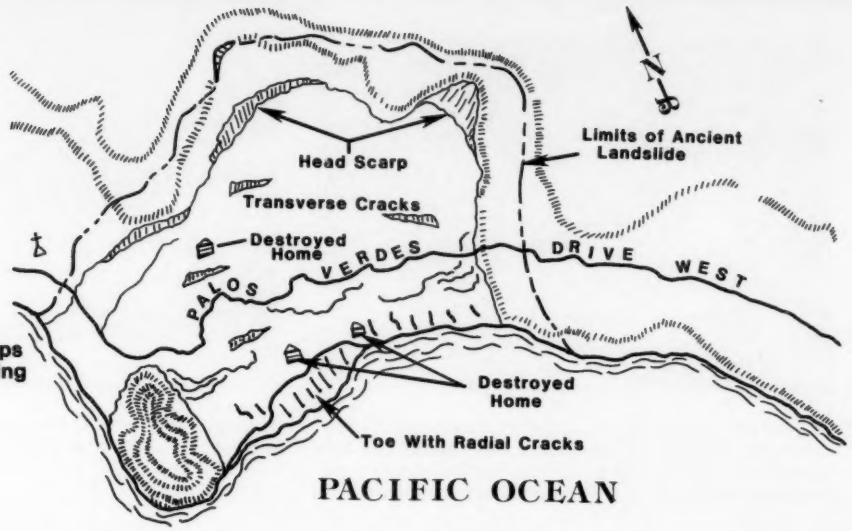


Figure 5. Portuguese Bend translational/rotational slide which occurred when development was allowed on an ancient slide mass. The Pacific Ocean keeps slope unstable by cutting toe.

or in combination with the agency report to give a more completely usable document. Some states and municipalities require a geologic report for all new construction.

Geologic reports are required in Los Angeles County but they weren't in the late 1940s. If they had been required, the Portuguese Bend disaster might never have occurred. The use of geologic reports would have also caused permits not to be issued and the county to be free from the millions of dollars in legal settlements following the disaster.

This was an isolated incident of major proportions but is a good lesson to all construction professionals as to what can happen if basic procedures are not followed.

Retain Walls and Buttresses — One of the more basic ways to help support a marginally stable or unstable slope is through the use of the retaining wall or buttress. If this method is used, be sure the wall is capable of withstanding the severe forces which could be exerted upon it. This means that it should have a deep, firm foundation, be reinforced, and the cap should be slightly narrower than the base (Figure 8).

Slope Reconfiguration — Since road cuts, site cuts, and fill slopes are often responsible for the instability of a slope when initially made, it is possible to restore that stability through the reconfiguration of the slope to a less steep angle. An unstable 1:1 cut may have its stability restored by reducing the angle to a more manageable 2:1 or 3:1 cut. If this is done and properly drained, the slope should hold (Figure 9).

Proper Drainage — Sometimes a slope may become unstable because it was improperly drained and the strata became oversaturated with fluid and failed. As cuts and fills are made, the site can be properly drained using pipes or channels. These can be parts of parking lots and driveways or included into the landscaping to make them less evident (Figure 10).

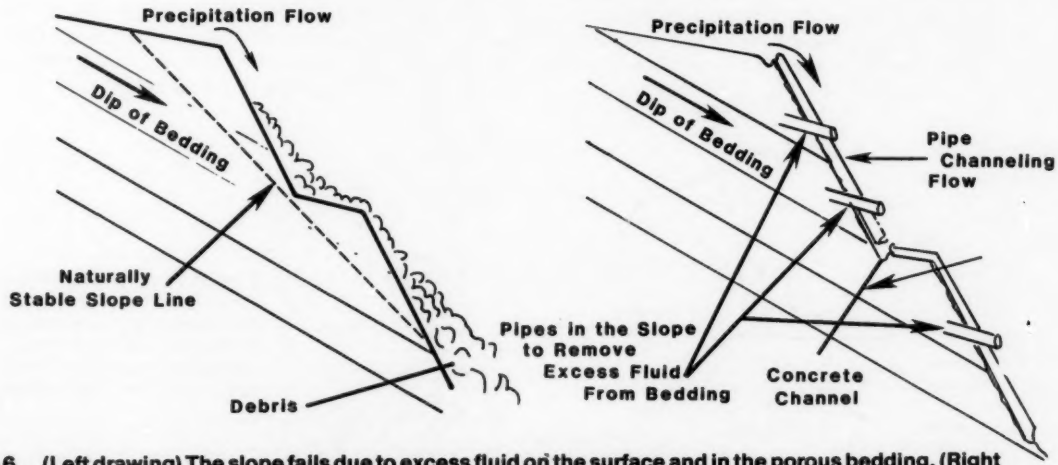
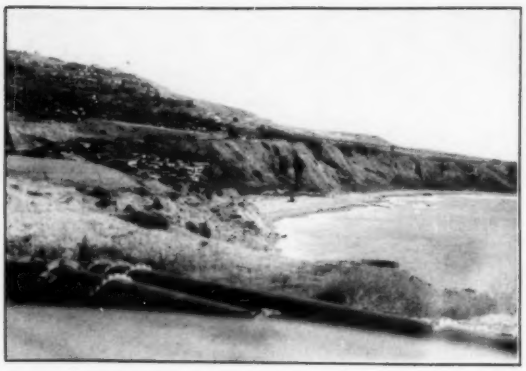


Figure 6. (Left drawing) The slope fails due to excess fluid on the surface and in the porous bedding. (Right drawing) The slope is stabilized by using pipes and concrete drainage channels to minimize the erosion on the face of the slope.

The offset caused by the four-inch average daily movement of the slide is visible. The flag (center left) shows the placement of strong motion indicating instruments used to measure slide movement.



Unstable slide toe at Portuguese Bend slide. In the foreground are surface-laid utility pipes.

Balanced Construction — This is this author's personal name for several things that involve slide prevention. First is the avoidance of overloading the overburden or strata. By changing the placement or designing the project with fewer structures you can reduce the load placed upon the site and limit the chances of the slope failing.

Included in this area is the use of quality materials. The project engineer must use good quality materials for retaining walls, drains, and other appliances.

Balanced construction also includes the use of any combination of procedures or techniques which will ensure the safety of those who must build the facility or use it after it is complete.

Legal Aspects — With the increase in concerns over the environment and user safety, numerous new statutes and regulatory bodies have come into being. Agencies such as the Environmental Protection Agency (EPA) or the California Coastal Commission (CCC) have mandated that the developers of projects will exert more care and responsibility in the development of said projects. This means that in some areas the geologic report becomes part of the environmental impact statement and can have a direct bearing on whether the permits necessary for the construction of the project will be issued.

Compression ridges and transverse cracking on the mass of the Portuguese Bend slide. The slide is dangerously close to residential structures.

Los Angeles County has even more requirements at the local level due to past problems and seismic activity. It is critical to know what the local requirements are. This will eliminate the need for repetitive work during the post-planning stages of the operation.

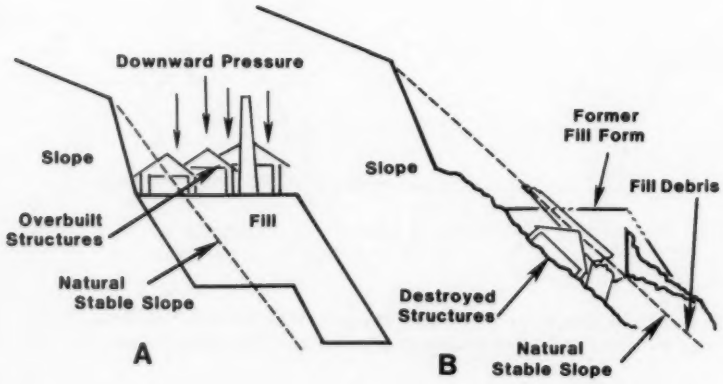


Figure 7. The stability can be removed from a slope cut or fill by overbuilding and exceeding the ability of a slope to carry the increased weight or both structures and the overburden.

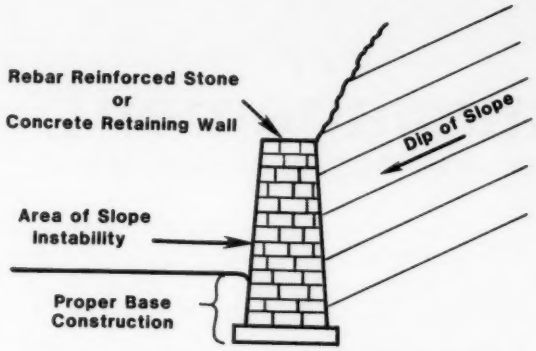


Figure 8. A retaining wall can be used to help stabilize a slope if it is properly built and reinforced to withstand the stresses exerted by the slope. Proper drainage will help make the wall a success by easing the stresses placed upon the wall.

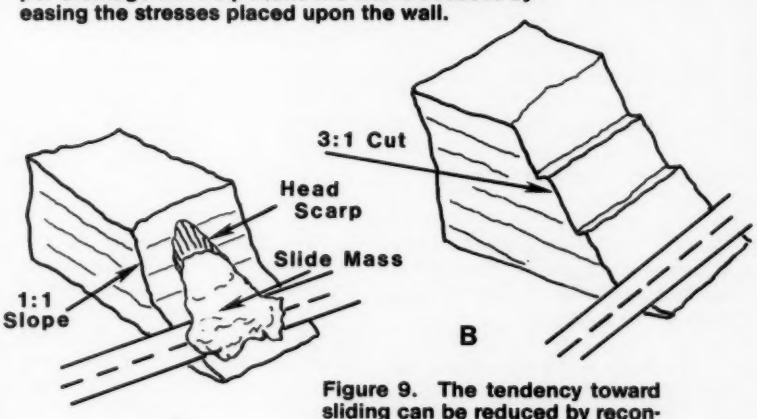


Figure 9. The tendency toward sliding can be reduced by reconfiguring a slope. The 1:1 slope is highly unstable but the terraced 3:1 slope with proper drainage becomes relatively stable.

SUMMARY AND CONCLUSIONS

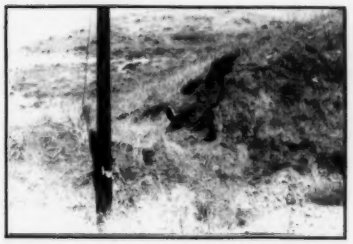
Summary — The problem which beset the homeowner in the beginning of this article is still around. It has beset man for eons and will do so as long as he builds in the hills. There are numerous causes of landsliding, some of them are natural and some are manmade. We have also looked at the major types of landslides and what man can do to prevent ot repair their damage. Finally, we have taken a very brief look at some of the legal aspects regarding the subject.

Conclusions — Because landsliding is such an inherent part of hillside construction it is imperative for those who design and build to follow proper techniques and procedures. It is also critical in light of new regulations for the project manager to be aware of the overall geologic conditions of the prospective construction site.

Many slides are caused by nature and there is little that we can do to prevent them. We must work to make safe repairs. Many other slides are due to incompetence or indifference to what is occurring. In this day of indiscriminant litigation it is critical for the architect or civil engineer to make sure that all safety facets are covered. Remember that the best way to limit problems is to plan for contingencies.

If proper procedures and good materials are used in the safety items such as retaining walls, these items will be able to withstand greater forces when they are exerted and many potential slides can be eliminated. This means that safety above all should be a project manager's chief concern when planning a project even if it costs a little more. The temptations are there to cut to the bone, but is the loss of life or subsequent property damage worth the cuts? □

Destroyed structure part is lying alongside the side scarp of the Portuguese Bend slide.



Utility pole being encroached upon and drain pipe which has been offset due to the effect of sliding at Portuguese Bend, California.

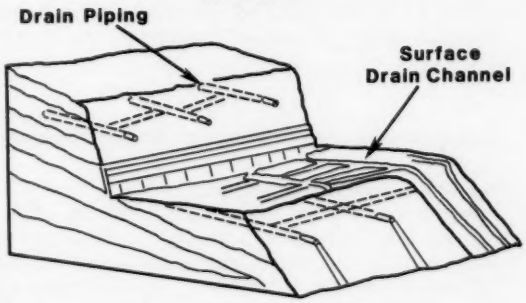


Figure 10. Site drainage can eliminate problems which occur when a site is subject to a great deal of water flow. Proper drainage can make a marginal site a workable one.

Environmental management:

Challenges and opportunities in the next decade

By PAUL J. YAROSCHAK
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Naval Facilities
Engineering Command
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"It was the best of times, it was the worst of times." This phrase from Charles Dickens' *A Tale of Two Cities* aptly describes my feelings about managing environmental programs in the Navy today. Never have we had so much to do. Never have we faced greater challenges; not just technical challenges, but challenges in fiscal and people management, public relations, contracting, meeting statutory and regulatory deadlines, and maintaining credibility with Congress.

In the 1970s, the thrust of the nation's environmental program was point-source pollutant discharge control. Standards were developed and thousands of permits for air and water discharges were issued. In response, we built electrostatic precipitators and other controls on power plants, upgraded sewage treatment plants, built industrial wastewater and oil spill prevention facilities, and installed sewage holdings or treatment systems onboard ship, all at a great cost.

The 1980s can be characterized as one of toxics "awareness" and control. The '80s have also begun the era of industrial birth control, also known as hazardous waste (HW) minimization.

The 1980s can be characterized as one of toxics "awareness" and control, or hazardous waste minimization.

Look to the challenges of the next decade. The current, most pressing challenge is the assessment and cleanup of contamination caused by past indiscriminate disposal of HW or accidental spills at our military installations. The comprehensive Environmental Response, Compensation and Liability Act (CERCLA), along with its "Superfund" amendments, requires an incredible amount of detailed site work, analysis, negotiation with state/federal regulatory agencies, and public participation.

Due to the size of the problem DOD-wide and the high level of public concern, Congress created a separate DOD appropriation for CERCLA compliance, analogous to EPA's Superfund. Because of this fund source, called the Defense Environmental Restoration Account (DERA), we have adequate funds to begin the assessments and cleanups. The overall program, known as the Installation Restoration (IR) program, is comprehensive and proactive.

How long will the source of funds last? Will it be adequate to complete the job? We don't know yet. We do know this. First, the United States has a massive federal budget deficit. As national leaders try to bring the deficit under control, all federal agencies will feel the pinch. We felt the first blows just after passage of the Gramm-Rudman-Hollings legislation. Another round of cuts is in the offing soon.

Second, the mission of DOD is defense. Environmental programs have a tough time competing. Federal facility sections in legislation and tough enforcement have helped, but they are not the answer. I believe the Navy, DOD, and possibly other federal agencies need to clearly and separately identify pollution abatement needs to Congress.

Much of our current pollution abatement effort is now "hidden" in

O&M accounts. And, since the costs are hidden, they detract from the defense mission. One could argue that these are just the costs of doing business. But there are two major problems with this approach in the federal sector (where it takes two to three years to program and receive funds).

First, it does not make Congress accountable enough for the staggering costs of pollution abatement legislation which they continue to pass and which usually requires compliance in relatively short timeframes. Second, it often forces a base commanding officer to make "no-win" choices between funding critical mission-oriented repair and construction projects or pollution abatement projects required by law or regulation.

Some people have suggested a separate account or appropriation (like DERA), outside the "normal" defense budget, which identifies for Congress the total cost of environmental compliance each year. Agency mission-oriented requirements can thus be debated and approved separately.

A long-standing problem is that of getting enough visibility for environmental programs from top management. Our peers in industry have the identical problem; and it is a classic "Catch-22." If we plan and program effectively, problems are eliminated before they become acute — thus, no attention. The attention and visibility usually go to those people putting out "fires," even if the fires were avoidable.

On the other hand, if we have lots of environmental problems, we're not doing our job effectively. The only partial answer I've found to this problem is constant communications and education of top management. The limiting factor here is time, on both sides. Fortunately, and unfortunately (another paradox), external forces and a few "environmental accidents" have dramatically raised program visibility in the Navy in the past year.

Notices of violation, threatened cease and desist orders, and a number of PCB transformer fires or releases causing contamination with costly cleanups have resulted in concern and a call for action at the flag level of the Navy. Most major commands are now beefing up their environmental staff. A flag level environmental steering group has been formed to alert top Navy decision makers to environmental issues impacting the Navy.

The Chief of Naval Operations (OP-45) holds a monthly meeting of Echelon II environmental coordinators to get early soundings on such issues and develop action plans and policies. The challenge for the Navy's environmental professionals will be to keep the visibility high while preventing problems and achieving compliance; not an easy balancing act.

Another challenge is a more practical one we face every day. The environmental manager today, at least in the Navy, is being drawn and quartered by what I call the "federal triangle," for lack of a better term. At the apex of the triangle, pulling in one direction, are the legislative and regulatory requirements and deadlines. At the second end, pulling in another direction, are the federal procurement regulations and agency policies with their lengthy advertisement, selection, notifications, audits, and "spread the work" requirements.

EPA's selection of contractors for the emergency response contracts (ERCs) clearly illustrates the problem of getting the job done as prescribed by the environmental law versus following all procurement requirements to the letter. In the EPA example, the job got done, but not without criticism from an EPA procurement audit team. Yet the team offered little advice to the poor program manager on how to meet the regulatory deadlines while jumping all the procurement hurdles.

The third end of the triangle is called "managing to payroll." Basically, it limits the amount of people we can hire. And again, environmental programs are competing with mission-oriented programs for a share of the salary dollars in a zero-sum game. Contracting out is a partial solution, but we have contracted out to the maximum.

A technically qualified staff is still necessary to specify, manage, review, negotiate with regulatory agencies. We are reaching the upper limits of contracting out at our present staffing levels.

Technical challenges abound. On-site or in-site HW cleanup technologies for past HW sites and in-plant HW minimization technologies for ongoing operations are the most current challenges. The next decade will see many environmental challenges. Toxic limits will be added and tightened on all of our wastewater discharge permits as we learn more about the chronic, long-term effects of these toxics. I think you will see bioassays and biomonitoring become routine in developing and maintaining these permits.

It will be up to our national leaders to figure out how much can be done without going broke.

Nationally, we haven't even scratched the surface of the nonpoint-source control issue. So far, it's been in the "too hard to do" basket. The control of volatile organic compounds (VOCs), both in air and in drinking water, will consume much of our time in the next decade.

I predict the control of chlorofluorocarbons may well become the next galvanizing, global environmental issue analogous to DDT and PCBs. However, I'm confident that given the right mix of time and money, the technical problems can be solved. It will be up to our national leaders to figure out how much of this should and can be done without breaking the national piggy bank. But our advice, all of us, will be important in those decisions.

For the motivated environmental manager, all of these challenges offer opportunities. I believe the keys to success are staying technically sharp in a dynamic profession, making full use of innovative technologies and contracting mechanisms, and being completely candid and open about our problems and the cost/benefits of proposed solutions. It can be the best of times, or the worst of times. □

A SEABEE PERSPECTIVE OF

Fleet hospital construction

By LT GREG SHEAR
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Fleet hospitals are designed to fill in the gap between battalion aid stations near the front line of battle and medical facilities outside the theater of war, such as hospital ships or stateside hospitals. They are expected to significantly improve the return to battle ratio of injured Marines and Navy personnel.

Twenty-three hospitals will eventually be prepositioned worldwide for rapid deployment. Each hospital costs approximately $25 million. The initial cost, coupled with maintenance and storage costs, makes this a $1 billion program stretching well into the 1990s. Two primary design criteria, and the two that most concern the Naval Construction Force, are: (1) a ten-day maximum set-up time, and (2) the hospital staff must be capable of assembling the facility with no outside help. To support this mission, each of the deployed hospitals is assigned either an active duty Seabee battalion detachment or a Reserve Naval Construction Force component for construction support and maintenance once operational.

In order to test the capabilities of the fleet hospital prior to prepositioning, the Chief of Naval Operations directed the program manager, fleet hospital program (PML-500) to conduct a follow-on test and evaluation (FOT&E) at Camp Pendleton, Calif., in the spring of 1987. During the FOT&E, Fleet Hospital No. 1 was to be assembled, operated for five days, and then repacked. NMCB-5 got the call to provide the complement of 60 Seabees required to staff Fleet Hospital No. 1.

Design

Fleet hospitals are fascinating and complex facilities. They are advanced base functional components (ABFCs) on a grand scale. Designed to be in storage, everything (with the exception of the 86 pieces of Civil Engineer Support Equipment [CESE] assigned) must fit into International Standards Organization (ISO) containers 20 feet by 8 feet by 8 feet in size.

Fleet Hospital No. 1 was transported from Alameda, Calif., in 340 ISO containers. To put that number in perspective, eight acres of laydown area were required at Camp Pendleton for Fleet Hospital No. 1!

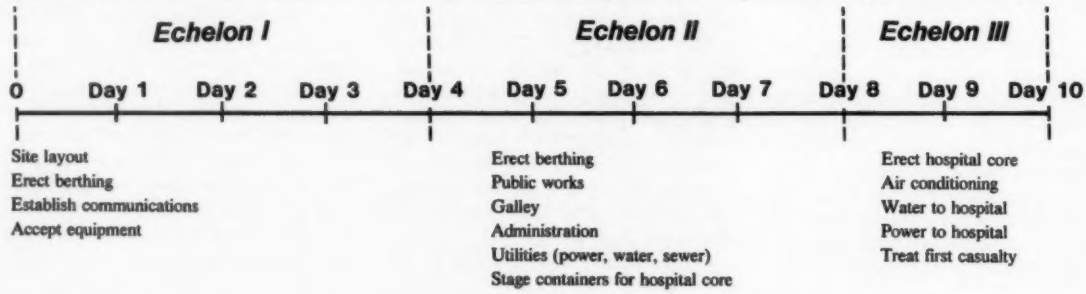
ISOs serve as working spaces as well as for storage and transportation. Eleven ISOs are expandable operating modules such as operating rooms, x-ray units, laboratories, and sterilization rooms. Twenty-one ISOs are staff and patient head units with toilets, sinks, and hot showers.

As "space age" as the ISOs seem, the system that makes a transportable fleet hospital work is a beautiful contraption called the Temper tent (tent, erectable, modular, personnel). Temper tents come in 20-foot-wide by eight-foot-long sections that combine to form wings. They are internally framed, triple-layered, lightweight, easy to erect, and—best of all—air-conditioned. Temper tents comprise the actual operating core of the hospital and the galley. Berthing is in general-purpose (large) tents.

Needless to say, all this sophistication requires power and water. Nineteen 100-kilowatt generators ring the 250-bed facility and 25 ISOs are ringed as tanks capable of holding 3,000 gallons of potable water each. Setting up the maze of utility services needed to turn on open field into a state-of-the-art medical facility was the Seabees' most difficult challenge.

Preparation

The 60-man fleet hospital detachment was assembled in January 1987. Twenty-six members of the detachment attended a nine-day course at the Fleet Hospital Training Activity on board Camp Pendleton. Other members traveled to Alameda, Calif., to visit the Fleet Hospital Sup-



port Office (FHSO) where the hospitals are packed.

Alfa company personnel were sent to Camp Pendleton to clear the 30-acre site where the hospital was to be erected. Plans and schematics were obtained for the involved utility systems. The actual assembly seemed straightforward enough if you could find everything. Three, six-inch-thick computer printouts and a 13-digit alpha-numeric code were used. (Fleet hospitals are now being retrofitted with computers.)

In meetings with the commanding officer (CO) of Fleet Hospital No. 1, Captain H. M. Koenig (CO, Naval Hospital San Diego), it was determined that the Seabees would be given complete control of the assembly process. The question now was how to coordinate the efforts of over 600 men and women from every medical command in Southern California with no established chain of command, no small unit leadership, and little experience in a field environment.

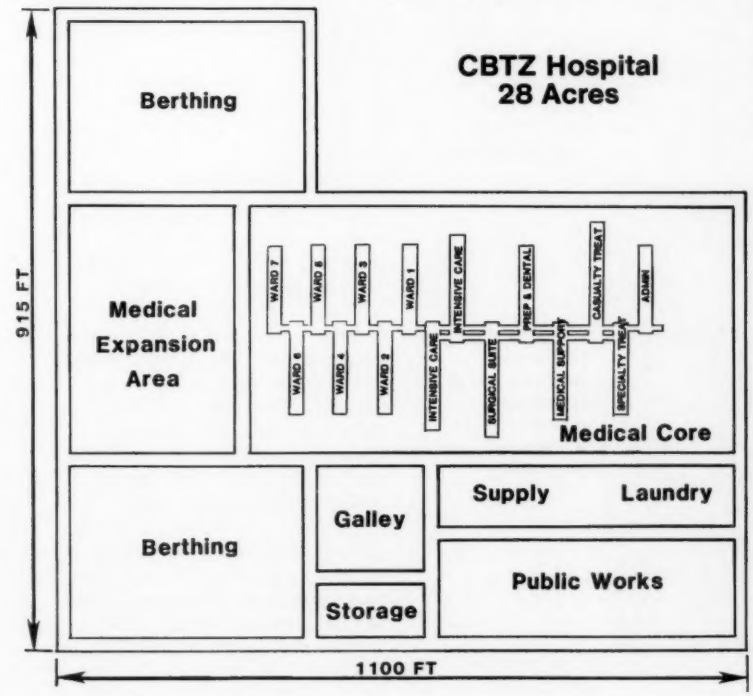
Inside Casualty Receiving. Visible are flourescent lights and central air conditioning and heating ductwork within the Temper tent.

Construction—Air Detachment

The activation plan for fleet hospitals calls for the arrival of personnel at the deployment site in three echelons: air detachment (det), advance party, and mainbody. Each echelon has discrete tasks to accomplish prior to the arrival of the next echelon. "Exercise Safe Haven" began with the arrival of the air det on April 22 at Camp Pendleton. Twenty-six Seabees arrived from NMCB-5 and were joined by 10 fleet ratings to begin unpacking. The task was a daunting one. Every one of the 340 containers would have to be moved and unpacked in the next 10 days.

In order to avoid double handling, it was essential that each container be placed correctly the first time; therefore, site layout and survey was the top priority. Within the hospital core, EA2 Stephen Landis was working with just inches of tolerance over the 800-foot length of the hospital core.

Working late each night, the air det moved ahead of schedule. By day three, they were already prepared for the arrival of the advance party and were rigging the first head units for hot showers.



Advance Party

With the arrival of 111 more willing hands, including 34 Seabees, work on all support services began in earnest. The site roared with progress as 20,000-pound-capacity container handlers relocated ISO containers, forklifts scurried about placing wooden crates, giant MRS tankers hauled in water, and helicopters buzzed overheaded recording the event.

CECS Dwayne Groshong and his hand-picked team of construction

electricians and utilitiesmen had the toughest assignment. The utility systems (in particular, the head units) required extensive field modification before bringing them on line.

Faced with the frightening prospect of 600 hospital staff and 250 patients with no place to go, the Seabees worked doggedly to make the systems work. With assistance from technical advisers down from FHSO and several sleepless nights, the 'Bees had all 12 head units up by the close of day eight. All support services were now in place around the hospital core.

Still remaining was assembly of 244 temper tent sections, stuffing the hospital with the tons of medical equipment required to operate; organizing the spaces for patient care; hooking up water, sewer, and electrical lines; placing 54 air conditioners; expanding the operating modules; and clearing the decks for the first patients. Help was on the way!

ISO containers were used in a variety of ways.

Mainbody

Four hundred seventy-two doctors, nurses, administrators, a hospital corpsman, and a myriad of other support personnel arrived by bus the morning of day nine. The challenge was to quickly organize this crowd and assimilate them into the construction organization. Having anticipated this problem for months, the Seabees now put their plan into action.

Two Seabees were placed in charge of each hospital wing. As each bus arrived, personnel (regardless of rank or specialty), were immediately split into construction teams and the senior member placed in charge. Beginning with specialty treatment and working through the hospital core, each team was responsible for one phase of the assembly process. The Seabees stationed at each wing provided continuity and kept track of the construction drawings as each team swept by.

Team 1 broke open crates, team 2 laid out material, team 3 assembled frames, etc. As opposed to functional area personnel building their own spaces, the "wave theory" of construction drastically reduced training time, kept mistakes to a minimum, and put people to work quickly in an organized fashion.

The hospital staff plunged in with enthusiasm and by sunset the entire hospital core was assembled and tied together by the central corridor. As each wing was completed, the functional area staffs were organized to begin moving medical gear into their spaces.

Seabees rushed to make utility connections, cleared out empty containers, and moved 20 tractor-trailer loads of now-useless packing material. On May 2, exactly 10 days after the air det arrived, the first patient was delivered to casualty treatment.

Seabees used headsets to communicate within the 30-acre site.

Lessons Learned

Data gathered during the FOT&E is being used to improve fleet hospitals. Volumes of recommendations, suggestions, and ideas were compiled by the 40 evaluators assigned to the exercise. The Seabees alone submitted 225 lessons learned and recommendations as well as equipment logs, consumption data, and maintenance records. Many Seabee innovations such as the wave theory have already been implemented in the assembly plan.

"Operation Safe Haven" tested not only the fleet hospital hardware but also the preparation, organization, innovation, and determination of 60 Seabees. Both passed the test, but learned plenty in the process. □

Navy minimizes/eliminates harmful asbestos exposure

By MICHAEL LARSON
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Naval Facilities Engineering
Command Headquarters

The Navy is one of the largest federal landlords of buildings, industrial complexes, and utilities systems. Many Navy facilities were constructed when asbestos was commonly used for insulation, fire protection, and as a general building material. Because of the identified health problems linked to asbestos exposure, the Navy has embarked on a major program to minimize or eliminate asbestos exposure in occupied spaces.

The Navy's Asbestos Management Program Ashore is designed to eliminate potential hazardous exposures to asbestos. The program contains five key elements: inventory, assessment, abatement, operation and maintenance (O&M) plans and training. The program is based on Occupational Safety and Health Administration and Environmental Protection Agency regulatory requirements and guidance documents. Information obtained from asbestos working groups consisting of representatives from the Department of Defense and other federal agencies, and input from other internal Navy organizations helped format the program specifics.

The Friable Asbestos Inventory has been developed to include certain types of asbestos-containing material (ACM). The ACM of the program's inventory includes surfacing materials, pipe and boiler insulation, and ACM that is currently friable and will most likely release asbestos fibers if disturbed. The Friable Asbestos Inventory includes all areas where spray-applied or troweled-on asbestos insulation or friable asbestos pipe and boiler lagging (i.e., building spaces, steam pipes, boiler rooms, steam trenches, other utility lines) occurs.

ACM that may not present a hazard in its identified state, but likely poses a potential exposure hazard when disturbed — most frequently drop ceiling tiles — is intended for the inventory. One sample for each homogenous material suspected of containing asbestos is called for during the inventory. A homogenous material is defined as being uniform in texture and appearance, installed at one time, and unlikely to consist of more than one type of formulation of material.

The Friable Asbestos Inventory is intended to identify and qualify potential existing asbestos hazards. The inventory is not intended to create asbestos hazards. Data from "destructive inventories," (i.e., cutting holes in intact walls to identify insulation) is not intended for the Friable Asbestos Inventory.

The Naval Facilities Engineering Command's regional engineering field divisions have been tasked to establish open-end inventory contracts for activities on a reimbursable basis. Parent commands were tasked to fund and ensure activity Friable Asbestos Inventories are proportionately conducted over a four-year period. Inventory data will be required on standardized inventory forms. Data will be recorded and prioritized by inventory areas according to the asbestos hazard and exposure potential in the workplace.

The next program element is assessment. Assessment determines the necessary corrective action. Comprehensive material sampling is intended during assessment. Sampling results is the basis for project design. Assessment actions include selecting the appropriate corrective actions and the abatement project design.

Abatement eliminates the asbestos hazard. Abatement actions include removal, encapsulation, and enclosure techniques, and/or a long-term maintenance program implemented after a corrective action project is complete.

Not all ACM requires abatement. Also, lag time exists between the completion of the inventory and the execution of a final abatement action. Therefore, O&M plans are necessary to minimize potential asbestos exposure during this period.

Individual activity O&M plans will be used for this purpose. These written activity O&M plans will address each type of ACM, note how to handle asbestos fibers previously released, note how to prevent further release of fibers by minimizing ACM disturbance and damage, and how to monitor the condition of ACM.

A generic asbestos O&M plan is being prepared that can be used by activities to develop their site specific O&M plans. This generic plan will include record-keeping requirements; ACM clean-up, patching, inspection, maintenance requirements; personnel training and medical surveillance requirements including custodial and maintenance personnel; posting and notification requirements; and guidelines that address future repair work or modifications to a building with ACM.

This generic asbestos O&M plan will provide the flexibility needed to develop an individual activity O&M plan that supplements current activity inspection, maintenance, and workplace monitoring programs. This generic plan is being developed by the Naval Energy and Environmental Support Activity (NEESA), located in Port Hueneme, California.

There are centrally managed asbestos hazards in Navy workplaces and occupied spaces. To tap centrally managed program funds for assessment and abatement projects, a Friable Asbestos Inventory is a prerequisite. The inventory data will be used as a management tool to ensure potential worst-case asbestos exposures are given the highest priority.

Compiled Navy-wide inventory data will also be used to develop future cost projections. Parent Navy commands are responsible for funding Friable Asbestos Inventories, employee training, and the development of their activity O&M plans. Activities also have the option of using their own operation and maintenance funds for asbestos projects.

The engineering field divisions are in the process of establishing open-end reimbursable inventory contracts for use by regional naval activities. Subsequent assessment and abatement contracts will be handled by the engineering field divisions after the asbestos inventory data is prioritized.

The funding for these contracts will come from the centrally managed asbestos funds administered by the engineering field divisions. □

A HISTORY OF

Navy military underwater construction

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Seabees of the Naval Construction Forces (NCF) became involved in construction diving during World War II in conjunction with the building of numerous advanced bases throughout the Pacific theater. Early projects included underwater demolition of reef obstructions, and in-shore construction necessary for development of channels, harbors, and mooring facilities for the fleet.

Most of the work was performed by specially trained Seabees qualified as divers assigned to the Naval Mobile Construction Battalions (NMCBs). During the same period, several small, semi-independent units were being formed to perform combat underwater demolition, limited salvage, and underwater construction.

These units were the predecessors of the Underwater Demolition Teams (UDTs), which originally included diver-trained Seabees and were led by Civil Engineer Corps officers.

The mid-1960s saw renewed interest in Navy ocean facilities engineering within the Naval Facilities Engineering Command (NAVFAC), the Navy's construction agent for fixed facilities. From this interest, the "Plan for Definition of NAVFAC and Naval Construction Force (Seabee) Role in Ocean Engineering" (Naval Facilities Engineering Command Summary Report 68-1), published in September 1968, identified the necessity for a military underwater construction capability.

The report recommended that one Seabee Underwater Construction Team (UCT) be located at each of the two Construction Battalion Centers, and one unit be located at the Navy Civil Engineering Laboratory, Port Hueneme, Calif. A UCT was subsequently established under the 21st Naval Construction Regiment (NCR) at the Seabee Center, Davisville, Rhode Island, in 1969 under the leadership of Lt.(j.g.) Scott Stevenson; while at the 31st NCR, Port Hueneme, Calif., Lt.(j.g.) Geoffrey Cullison was assigned as the staff diving officer. The 31st NCR began organizing an enlisted Seabee diver staff in 1971.

In December 1968 the Ocean Engineering Program Office (PC-2) was formally created within NAVFAC Headquarters to serve as the focal point for the development of an integrated NAVFAC ocean engineering program. Cdr. Walt Eager, previously of the Navy Deep Submergence Systems Project office, was appointed as the director and officer in charge of construction for this new office providing the initial guiding force for the infant Ocean Facilities Program. Dr. Michael Yachnis, today the chief engineer at NAVFAC Headquarters, served as the engineer in charge, while LCdr. Osborn was assigned as assistant to Cdr. Eager.

In late 1969, the Ocean Facilities and Construction Project Office, Chesapeake Division FPO-1, was established as recommended by the NAVFAC Summary Report 68-1. Cdr. Larry Donovan served as the first director of this office providing state-of-the-art engineering, project planning, and execution in support of the UCTs and other underwater construction projects.

Three ocean facilities projects undertaken by NAVFAC and the NCF in the late 1960s served to establish the capabilities of the Ocean Facilities Program. In February 1969, a team of approximately 20 Seabee divers was assembled from the 21st NCR and individuals serving with the NMCBs to provide underwater construction support for the TEKTITE I undersea habitat launched in the Caribbean Sea near St. John, U.S. Virgin Islands, in 52 feet of seawater (fsw).

The Seabee diving team was operationally attached to Amphibious Construction Battalion TWO (ACB-2). The ACB additionally provided a causeway construction team and camp support personnel. Installation of the 160-ton TEKTITE I undersea habitat was accomplished without the use of a floating crane using an "underwater elevator" lifting system assembled from a locally available Ammi pontoon section.

Second, construction operations on the test array installation of the Azores fixed acoustic range (AFAR) commenced in March 1970 at the Atlantic Undersea Test and Evaluation Center, Andros, Bahamas, in 1,300 fsw. This was an international project, involving the efforts of Germany, France, the United Kingdom, Italy, Portugal, Canada, and the United States. This was the first project accomplished by the newly formed unit at the 21st Naval Construction Regiment; it was then being called UCT-1 but deployed as 21st NCR Detachment Yankee.

This project included landing of emplacement of a fixed deep ocean acoustic antenna array, and power and signal cables to a control van ashore. Then, during the summer of 1970, the UCT-1 divers installed four large, double-armored power and signal cables at Santa Maria island, Azores, for the evaluation phase of the AFAR project.

The AFAR project required underwater explosive demolition producing a trench through the precipitous basalt submarine island shelf, and installation of 1,500 feet of split pipe to each of the armored cables. The Seabee divers devised an innovative procedure for application of the split pipe, weighing 60 pounds per three-foot section, by under-running the cable with a causeway section and applying the split pipe on deck.

The industry practice of applying the split pipe with cable in place on the ocean bottom would have increased the project time for split pipe installation by a factor of 15.

Installation and cable stabilization techniques learned during these projects set a standard for many future cable projects successfully completed by the UCTs in the years to follow. Other projects accomplished by the Underwater Construction Units included pier reconstruction at Mc-Murdo Station, Antarctica, and cable installation and stabilization in Iceland.

During the Vietnam war, diving Seabees served with the NMCBs deployed to Southeast Asia. Their primary tasks included repair of war-damaged waterfront facilities, and construction of new bridges, piers, and POL (petroleum, oils, and lubricants) facilities. Often the only diving personnel available, they also performed small boat salvage operations and security inspection swims on bridges, piers, and underwater fuel lines.

Commencing in 1971, underwater construction divers were assisting with the building of the naval installation at Diego Garcia, British Indian Ocean Territory.

Seabee divers, then attached to NMCB-74, performed a variety of harbor maintenance and construction services including mooring and underwater connection of fuel and cement transfer lines ashore, inspection and repair of the underwater pipelines, recovery of equipment dropped overboard during supply ship cargo transfer operations, inspection and repair of all channel marker and fleet mooring buoys, and repair of the offshore sewage outfalls.

Seabee divers at Diego Garcia also performed all subsurface maintenance on the desalination barge which required blasting a new trench for barge mooring at the industrial "I" site.

In 1970, the Chief of Naval Operations authorized the consolidation of the Seabee diving resources from the NMCBs into two units attached to the NCRs. The mission of the new underwater construction detachments was formally defined by OPNAVINST 5450.198 in 1970. This mission vested within the Naval Construction Force detachments the responsibility for Navy ocean facilities engineering, construction, and repair of underwater facilities.

Later, recognizing the need for a permanent capability for harbor, waterfront, and ocean construction, the CNO formally established UCT-1 and UCT-2 on November 1, 1973, under the 21st and 31st NCRs, respectively.

The two teams were then geographically located at the Naval Construction Battalion Centers, Davisville, R.I. (UCT-1) and Port Hueneme, Calif. (UCT-2) under the command of an officer in charge. With the disestablishment of the 21st NCR in 1973, UCT-1 was relocated to the Naval Amphibious Base at Little Creek, Norfolk, Va.

The early teams were composed of 12 to 15 Seabee divers with additional divers and support personnel assigned for temporary duty from the NMCBs as project needs required. With the growing workload and complexity of projects, the team manning grew to approximately 28 enlisted (four on the shore component) and two officers. A manpower initiative for 1983 increased the sea component by 68 percent to 41 enlisted.

Additionally, this initiative increased the officer complement to three upgrading the operations officer billet to the grade of warrant officer, proportionate with the increased workload. Diving statistics reflected the increasing workload during the early years.

Underwater Construction Team ONE logged 404 dives in 1971; in 1977 they logged 623. Underwater Construction Team TWO's 265 dives in 1971 increased to 1,319 in 1977. The maximum dive depths and bottom times were typically less than 70 fsw and 60 minutes: however, both teams have since developed full deep-sea-air diving capability to 190 fsw, and now regularly employ advanced deep diving techniques such as surface decompression using oxygen.

In 1979, the two small teams were performing 3 percent of all Navy working dives, according to Naval Safety Center statistics. The two teams continue to perform an extraordinary share of all Navy working dives.

On October 1, 1985, the command status of the Underwater Construction Teams was upgraded to commanding officer consistent with expanded mission requirements assumed during the brief history of the teams. The current UCT mission statement established by OPNAVINST 5450.198A including the requirement to be capable of fielding three vice two air detachments per team, the first within 48 hours of notification.

Few in number, UCTs have performed in many isolated areas.

The stated mission of the UCTs is to: (a) accomplish project planning, construction engineering, site surveys, develop material requirements, and conduct diving operations for construction, repair, and inspection of ocean and waterfront facilities; (b) serve as the construction agent for the installation, inspection, maintenance, and repair of undersea range facilities, and inshore cables for undersea surveillance facilities; (c) support other NCF units including Amphibious Construction Battalions on projects that include construction, inspection, or repair to waterfront and strategic sealift facilities; and (d) assist in the test and evaluation of new underwater construction equipment and ocean facility structures and components.

Teams are divided into a sea and a shore component and are presently manned by three officers and 52 enlisted men. Although few in number, the UCTs have performed numerous projects in many geographically isolated areas, from the Arctic Ocean to the Antarctic, to the Caribbean and Mediterranean Sea; from the Indian Ocean to the Pacific and North Atlantic Oceans.

They have accomplished diverse tasks, from major fleet and specialized mooring installations such as refurbishment of the 21 mooring legs on the *USS Los Alamos* at Holy Loch, Scotland, to new pier construction at the Naval Facility at Argentia, Newfoundland, and repair of over 400 deteriorated concrete pier pilings at Naval Station Guantanamo Bay, Cuba.

UCT-1 has used controlled precision underwater blasting techniques to remove damaged reinforced concrete pier decking at Naval Station Rota, Spain, and most recently assisted with the installation of 18 hydrophone arrays and over 300 miles of signal cable in over 15,000 fsw at the Atlantic Fleet Weapons Training Facility, St. Croix, U.S. Virgin Islands.

UCT-2, the Pacific team, has successfully accom-

plished fleet mooring renovations at NAVBASE Subic Bay, Republic of the Phillipines, and Deperming range inspections and repairs at submarine base Bremerton, Wash., using the Mk 12 Surface Supplied Diving System in 150 fsw. UCT-2 is presently the primary construction agent for installation of the Southern California Acoustic Range (SOAR) at San Clemente Island, California.

Both teams perform significant underwater cable and pipe installations and repairs. Each team annually invests over 20 percent of the available deployment season to underwater cable and sensor installation and repair in support of the various underwater acoustic ranges such as AUTEC, Barking Sands, Kauai, and the Atlantic Fleet Weapons Training Facility.

Today's UCTs have accumulated numerous unit proficiency awards and consistently receive letters of adulation from project customers for the quality and efficiency of their work. UCT-1 has earned three Meritorious Unit Commendations and one Navy Unit Commendation between August 1979 and June 1983, while UCT-2 has earned four Meritorious Unit Commendations and one Navy Unit Commendation between August 1971 and November 1980.

Diving Seabees receive initial training, following thorough physical and performance screening, at one of the second class dive schools. Successful completion of diver training qualifies the new candidate for attendance of Underwater Construction Technician basic training at the UCT School, delta company, at the Naval Construction Training Center (NCTC), Port Hueneme, California, for a period of nine weeks.

A member of the UCT family can expect career development in various underwater construction billets at one of the Navy Underwater Construction Teams or at the Naval Civil Engineering Laboratory (NCEL) diving locker. After a few years' experience with one of the UCTs, the Seabee diver is screened for first class dive school and attendance of the advanced UCT course at NCTC Port Hueneme for a period of eight weeks.

The author wishes to acknowledge the extensive editorial support and historical background provided by Cdr. Scott Stevenson, presently assigned as Commanding Officer, Naval Amphibious Construction Battalion TWO. Contributions by Lt. Rob Westberg, Senior Chief Builder Phillip Pronia, and Senior Chief Builder Joel Hierholzer (Master Diver) were also greatly appreciated.

The ultimate accomplishment for the most motivated and qualified individuals is attainment of Master Diver and service with one of the teams or the NCEL diving locker as the diving master and senior underwater construction technician.

The Navy Underwater Construction Teams are highly mobile units staffed by exceptionally professional construction divers capable of executing highly complex ocean construction projects under the most adverse conditions. With research and development support from the NCTC Port Hueneme, California, providing trained underwater construction technicians, and project engineering provided by the Chesapeake Division Ocean Engineering and Construction Project Office, the Underwater Construction Teams are ready to meet the challenges of ocean construction supporting the U.S. Navy and Fleet Marine Force. □

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Navy Civil Engineer

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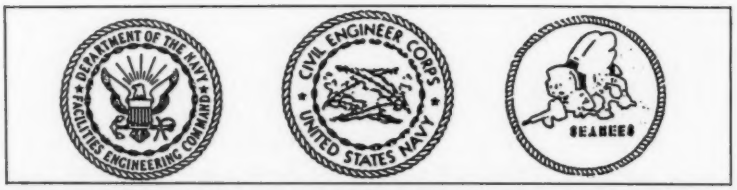

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